THE

AMERICAN NATURALIST.

VOL. XXI. DECEMBER, 1887. NO. 12.

HOW THE GREAT NORTHERN SEA-COW (RYTINA) BECAME EXTERMINATED.

BY LEONHARD STEJNEGER.

THE conclusions in regard to the extermination of the Great Northern Sea-Cow (*Rytina gigas*) and the causes which led to it, arrived at by the Russian naturalists, Von Baer and Brandt, and by them discussed in numerous publications, were regarded as final, and were generally accepted, until Prof. A. E. Nordenskiöld recently made the startling announcement that, during his five days' stay at Bering Island with the "Vega," he discovered incontrovertible evidence that at least one sea-cow had survived the general slaughter, and had been seen alive as late as 1854, or more than eighty years after the last one was supposed to have been killed. This statement of Professor Nordenskiöld was based upon his interpretation of an account of a strange sea-animal which two Bering islanders claimed to have seen some time previously. Nordenskiöld gave no details to speak of, merely asserting that the description of the animal by the natives tallied so completely with Steller's description of the sea-cow as to leave no doubt that they had really seen a living Rytina; but, notwithstanding this meagreness of the account, the weight of Nordenskiöld's name was then so great that his assertion would probably have been generally accepted. It was my good fortune to spend a year and a half on Bering Island three years after Nordenskiöld's visit, and, as the readers of the "Proceedings of the United States National Museum"[1] will know, I succeeded in bringing to light a number of facts which

[1] Vol. vii., 1884, pp. 181–189.

prove conclusively—as I have published even the minutest details, any one can make up his mind as to the weight of the evidence—that the animal seen by the men was *not* a sea-cow, but that, in all probability, it was a stray female narwhal. To this Nordenskiöld has had no other reply than a reprint of his former assertion, without even an attempt to give any further details or to refute my arguments. The only new point in his answer is an effort to throw discredit on the accuracy of Sauer's "Account of Billing's Expedition in the Years 1785 to 1794," in which Sauer expressly states that the last sea-cow was killed at Bering Island in 1768, twenty-seven years after the island had been discovered by man. In a paper published in the *Bulletin of the American Geographical Society*[1] I have already been able to vindicate Sauer. In the present paper I shall, therefore, only try to demonstrate how easy it is to account for the rapid extermination of this huge animal, if we take all the known facts into consideration. To any one familiar with the literature on the subject such an undertaking might be supposed to be superfluous, so well has the task been performed long ago by the great Russian scientists already referred to; but I may perhaps be able to elucidate the subject a little further,—a labor apparently not quite unnecessary, in view of the following remarkable statement of Professor Nordenskiöld (*Bull. Amer. Geogr. Soc.*, 1885, p. 281): "It cannot very well be supposed that in a sea so rarely visited in the last century as the northern part of the Pacific Ocean the last specimen of the genus Rytina should have been slain by the harpoon of the hunter. I even imagine that the hardly accessible coasts of Bering and Copper Islands have been very rarely visited by hunters since Steller's day, 1741." As will be seen from the following pages, there was no need of "imagining" anything of the kind, when the facts, as related in the literature, so amply prove the contrary.

As everybody knows, Bering and his unfortunate comrades, among them the immortal Steller, in the autumn of 1741, discovered the then uninhabited island which afterwards received its name from Bering, who died there shortly after. The survivors of the expedition wintered on that island, and when they landed there they saw the first living sea-cows (Rytina) ever beheld by white men.

[1] 1886, No. 4, pp. 317–328.

Unfortunately, Steller, in describing this animal and its habits, only says that he found it numerous and in herds, without stating exactly how numerous or in how large herds. We are thus left to guess at their probable number when first found; and from what he says in regard to their habits and the places they frequented, and from what I know of the natural conditions of the island, I should regard fifteen hundred as rather above than below the probable number. It must be remembered that the sea-cow was an extremely bulky animal, twenty-four to thirty feet long, which lived chiefly near the mouths of the rivulets, feeding on the sea-weeds, especially the large Lamellarias. There are hardly more than fifteen places on the island which could afford them suitable grazing-grounds, and if each of these were regularly visited by an average of one hundred animals, one would easily be impressed by their number, especially if divided up into five to ten herds of from ten to twenty individuals.

There can hardly be any doubt that these animals were the last survivors of a once more numerous and more widely distributed species, which had been spared to that late date because man had not yet reached their last resort. It is, then, pretty safe to assume that this colony was not on the increase, and that, under the most favorable circumstances, the number of surviving young ones barely balanced the number of deaths caused by the dangers of the long winters. Under this supposition, every animal killed by a new agency—in this case by man—represents one less in the total number.

No sooner did the survivors of Bering's expedition return to Kamtschatka, in 1742, than hunting expeditions were fitted out; for already, in 1743–1744, we find Bassoff and his crew wintering on Bering Island, and from that year and until 1763 hardly a winter passed without one or more parties spending eight or nine months in hunting fur-animals there, during which time the crews lived almost exclusively on the meat of the sea-cow. But that is not all, for more than half of the expeditions which wintered there did so for the express purpose of laying in stores of sea-cow meat for their farther journey, which usually lasted two to three years more.

In order to substantiate the above assertion, I shall give a detailed list of the expeditions which are *known* to have wintered on Bering Island during the twenty years in question. The old

records are very defective, and it is extremely probable that many more of the expeditions which left Kamtschatka in order to hunt and trade on the Aleutian Islands and in America stopped at Bering Island, as was the usual custom; but we shall only enumerate those of which the records expressly say that they wintered there. The number of men employed on the vessels is not given in all instances, but, as it varies between thirty and fifty, I have estimated it to be thirty in most cases of which we have no definite record. In the few instances in which the length of time spent on the island is not given I have estimated it to be eight months, which is shorter than the shortest time actually recorded:

Winter.	Name of Owner or Captain of Vessel.	Men.	Months.	Remarks.
1743–1744..	Basoff.....	(30)	(8)	Numbers in parentheses estimated.
1745–1746..	Basoff.....	(30)	12	Months, only approximate figures.
1747–1748..	Kholodiloff...	50	9	
1748–1749..	Bakhoff.....	(30)	11	
1749–1750..	Tolstykh.....	50	8½	
1751–1752..	Yugoff.....	26	(16)	There is some uncertainty about the time Yugoff spent on Bering Island. He is said to have wintered from 1751 to 1754 on Bering and Copper Islands,—about thirty-two months. It is not probable that he spent less than half of this time on Bering Island.
1752–1753..				
1753–1754..	Kholodiloff...	34	10	
1754–1755..	Drushinin....	(30)	(8)	
1754–1755..	Durneff.....	(40)	(8)	
1754–1755..	Krassilnikoff.	(30)	9½	
1754–1755..	Jakovleff.....	33	(6)	
1755–1756..	.....	4	.....	These four men belonging to Drushinin's crew were left behind.
1756–1757..	Krassilnikoff.	(34)	(8)	Krassilnikoff's crew and four of Drushinin's.
1756–1757..	Tolstykh.....	38	9	
1757–1758..	Shilkin.....	39	(8)	
1758–1759..	Paikoff.....	45	9½	
1760–1761..	Tolstykh.....	(38)	8½	
1762–1763..	Korovin	45	9½	
1762–1763..	Medvedeff....	45	(9)	

It will be seen that there wintered in 1754 to 1755 about one hundred and thirty-three men, and in 1762 to 1763, ninety men.

In addition to the above, we know of a number of expeditions wintering on Copper Island, and many more which passed by the Commander Islands on their way east. Besides, how many were there of which we know nothing? And yet Professor Nordenskiöld imagines that these islands "have been very rarely visited by hunters since Steller's day,—1741"!

Some of the records in regard to the above expeditions are

very interesting as having a direct bearing on the question before us. Thus, it is said, *à propos* of Krassilnikoff's wintering on Bering Island, that "it had already become customary for all vessels intending to hunt sea-otters on the more distant islands to winter there [Bering Island] in order to provide sufficient stores of the meat of the sea-cows (*Manati*)." These expeditions lasted usually three to four years, and it is safe to assume that they laid in provision for not less than twelve months. Of the expeditions enumerated in the above list, ten, with an aggregate of about four hundred men, belong to this category.

Still more valuable are the details which have been recorded in regard to Jakovleff's expedition. He was a mining engineer, consequently a man of education and intelligence, as his reports also testify, sent out by the Russian government in order to investigate the alleged occurrence of native copper on Copper Island. The records show, beyond dispute, that when this island was first visited (1745 to 1746) sea-cows occurred along its beaches (and I myself have found remains of them on that island); but in 1754, when Jakovleff was to explore Copper Island, he was obliged to winter on Bering Island, *because at that early date, nine years after the first visit, the sea-cows had been extirpated on Copper Island by man!*

Including his crew, there wintered that year, on Bering Island, hardly less than one hundred and thirty-three men, one of the chief occupations of whom it was to procure, during eight months, as much sea-cow meat for their future expeditions as they possibly could. This was done regularly by harpooning the animal from a boat manned with eight oarsmen, and when killed it was immediately towed to the shore to be hauled up on the beach and cut up at once, as the meat would spoil if left unattended until the next day. This was the method for securing provisions for the vessels, but a much more wasteful manner was pursued in killing the animals which served as food for the hunters during their sojourn on the island. From Jakovleff's diary we learn that the hunters were scattered all over the northern (*i.e.*, northern and eastern) shore of the island by twos and threes for the sake of catching foxes and other fur-animals, while sea-cow meat was the only food available.[1] These

[1] It is even probable that Jakovleff refers to a more or less regular population of hunters, in addition to the crews of the wintering vessels.

men, in order to obtain food, had to secure their sea-cow single-handed, and whenever they got an opportunity—what they often did—they would sneak up to an animal lying close to the shore or in shallow water, and wound it mortally by thrusting the iron-shod pole into it. The animal, which was hardly ever killed outright, sought the high sea and died there. If it drifted ashore the same day, well and good; but in most cases it came in unfit to be eaten, if it was not carried away altogether. So impressed was Jakovleff with the extreme wastefulness of this method that he predicted the speedy extermination of the sea-cow unless some precautions be taken against this senseless slaughter; and when, in 1755, he returned to Kamtschatka, he presented a petition to the authorities there that it be prohibited by an ukas to kill sea-cows in this manner, "in order that Bering Island may not be devastated in the same manner as Copper Island." Of course, nobody heeded this eminently wise suggestion, and the result became as he had predicted it: the last sea-cow was killed within thirteen years.

Can anybody who contemplates the fact that the sea-cow was an exceedingly stationary animal, which was bound to the kelp-fields near shore; that it was extremely stupid and sluggish; that it was deprived of the faculty of diving; and that the island offers absolutely no shelter or concealment for it,—can anybody, after having read Jakovleff's report and petition, possibly entertain a doubt that the last specimen of the genus Rytina was slain by the harpoon of the hunter?

But let us attempt a calculation, based upon the former guess as to the original number of living sea-cows when Bering Island was first visited, and upon the facts as they have been presented above. Before doing so we will have to estimate the number of animals wastefully slaughtered, and from the statements made by Jakovleff I should think it no exaggeration to say that there were killed five times as many animals as were actually utilized. From Jakovleff's report we learn that one sea-cow would furnish food sufficient for thirty-three men during a whole month, and, although it is probable that he made his party utilize each animal in a higher degree than the other hunters, we shall take the above figures as indicating the average. It will be seen that we do not take into account Burdukovski's statement, that only the kidneys were eaten, for he only had his knowledge from hearsay,

while from Jakovleff's diary it seems evident that all the meat was eaten. This is an additional reason why no weight should be attached to the rest of Burdukovski's story.

Now, to supply the six hundred and seventy men which we know wintered on Bering Island between 1743 and 1763, during an average time of ten months, it required, in round figures, about two hundred and five animals. According to the same method of calculation, we find that the four hundred men who laid in provisions for protracted journeys would require about two hundred and ninety animals for an average time of twenty-four months,—together, four hundred and ninety-five animals. If five times as many cows were wantonly killed as were utilized, we have a grand total of two thousand four hundred and seventy-five sea-cows slaughtered up to the year 1763, or nearly one thousand in excess of our estimate of the original number. We can therefore either admit that there were more than two thousand living sea-cows when Steller discovered them, or else that only twice as many animals were wasted as were properly utilized; but, whatever conclusion we choose, it is manifest that our estimates have been very reasonable.

From 1763 the visits to Bering Island seem to grow scarcer; at least, the records contain nothing definite that I am aware. This is probably due to the very fact that sea-cows had now become so nearly exterminated that the few left were insufficient to maintain any wintering and foraging expedition, while, at the same time, the fur-bearing animals were also so badly decimated that it would not pay for a large party to hunt them. The smaller animals, as we know, would recuperate when left undisturbed for a few years, and it was probably by a party who went out to Bering Island in 1767 or 1768—possibly on one of Popoff's vessels—in order to catch blue foxes that the last sea-cow was mercilessly killed. Four years after, in 1772, Dmitri Bragin again wintered on Bering Island, and, from the fact that in the list he gave of the animals of the island he omitted the sea-cow, it is reasonably safe to conclude that not one was left to be recorded by him.

After all, there is nothing surprising in the speedy extermination of this clumsy animal, which could not dive, and which had actually no means of defence or escape. It is too well known that it did not emigrate, and the theory that it was driven off to

other places is not only directly disproved, but is quite unnecessary in order to explain the sudden disappearance of the Great Northern Sea-Cow from the shores where it was first discovered.

I think it will be admitted that we have succeeded in materially strengthening Sauer's assertion, that the Rytina was exterminated in 1768, and that the above is a fair exposé of the causes which led to its final extirpation. It was simply due to man's greed, and he accomplished it within the short time of twenty-seven years.

THE MATERIALS OF THE APPALACHIANS.

BY E. W. CLAYPOLE.

(Concluded from page 962.)

The Four Great Sandstones of Pennsylvania.

IN the former part of this paper I dwelt on the fact of the existence of several thick sandstones and quartz conglomerates in the massive palæozoic deposits of Pennsylvania. I further showed that these rocks indicate a supply of quartz far greater than could be furnished from any existing source; and, thirdly, that the nature of this quartz is such that the only known origin for it is the quartz-ledges of the South Mountains. Hence I inferred the former extension of these strata over a greater extent of country than at present.

In this second part I propose to try and give a more definite shape to this conclusion, and to at least suggest where and when this palæozoic land existed.

Excluding, for various reasons which it is not necessary here to mention, the Potsdam Sandstone, there remain four great sheets of sandstone, more or less conglomeratic, in the immensely thick palæozoic deposits of the Eastern States. Between them there lie massive, softer deposits of shale and limestone. In descending order these beds are as follows, omitting all minor and insignificant layers:

		Feet.
	Shale, coal, sandstone	Variable.
4	Sandstone and pebbles (Pottsville Conglomerate)	1500
	Shale (Mauch Chunk)	1500
3	Sandstone and pebbles (Pocono Conglomerate)	2000
3	Sandstone and pebbles (Catskill Sandstone)	6000

		Feet.
	Shale and limestone (Devonian)	4000
2	Sandstone and pebbles (Oriskany Sandstone)	300
	Shale and limestone (Lower Helderberg, etc.)	300
1	Sandstone and pebbles (Medina, Oneida, etc.)	1500
	Shale and limestone (Trenton, etc.)	5000
	Sandstone (Potsdam)	400

Here are four vast beds of sandstone, all more or less conglomeratic, lying between thick masses of softer rocks. In ascending order they are the Medina, the Oriskany, the Catskill-Pocono, and the Pottsville. They vary in hardness, in thickness, and in coarseness, but they all agree in being composed of almost nothing but quartz in the form of pebbles and of sand.

Now, we are quite safe at the outset in asserting that these four great sandstones, with their alternating shales, represent as many changes in the conditions of deposition. The geographical arrangement of land and water that allowed the deposition of shale would prevent that of sandstone. Results so different argue different causes. Regarding the origin of the shales I do not now propose to inquire, and will therefore dismiss them without further notice, and refer only to the four great sandstones already mentioned.

It is obvious that each of these implies the destruction of an equal amount of rock elsewhere. They were not made from nothing. Inch by inch and pound by pound they and their pebbles represent and measure the rock whence they were hewn. So vast an accumulation of quartz, therefore, implies an equally large quarry from which it was obtained. But no such quarry exists; it has entirely disappeared.

Again, these four sandstones in succession imply not one but four quarries, and the consent of geologists is universal that these quarries must have been in the East; that this sand and these pebbles have travelled to the West and the Northwest.

I am inclined, therefore, to read in these four sandstones a record of changes which the eastern part of the country underwent during the palæozoic era. Reasoning back from the effect to its cause, I think we may see in them a history of what was occurring elsewhere during their formation.

Where, then, shall we seek the Eastern quarry of quartz-rock from which the massive Medina Sandstone was derived? It

seems to me that in this great conglomerate mass we have a record of a lost quartz-ridge or reef that existed in Middle Silurian days, but which long ago disappeared,—a reef of rock like that which now forms the ledges of the South Mountains; a ridge large and enduring enough to furnish all the sand and pebbles required, though the Medina is, in some places, two thousand feet thick.

Nor is the existence of such a lost ridge along the Atlantic sea-board altogether imaginary. We know that in later days a force has acted in the same region that was fully capable of producing such a result; and we have no reason to assume that the tangential pressure which at the end of the palæozoic era crumpled the crust and raised the Appalachian arches acted then for the first time. The grand catastrophe which shaped our Eastern States and closed the palæozoic era in North America may have been not its first, but its final, manifestation, and may have been preceded by others of equal, or even of greater, intensity. It is by no means unlikely that the same force that raised the Allegheny Mountain arches also raised, in Mid-Silurian days, a similar arch of the hard, semi-crystalline rocks like those of the South Mountains, from whose wreckage the Medina Sandstone was made. As it rose it was torn down by the waves, its quartz dispersed, and a new rock formed at a lower level.

A time of rest ensued. The deposition of quartz ceased and the Upper Silurian rocks were formed. But the resting stage came to an end and the earth-force again manifested itself. New crumplings set in and a new ridge was elevated, which we may call the Oriskany Ridge, as from its material the Oriskany Sandstone was probably formed. This, though thin when compared with the massive Medina, covers an equal or a greater extent of country, and in material the two can scarcely be distinguished.

Rest again ensued, and the formation and deposition of sand and pebbles again ceased. The huge beds of the Lower and Middle Devonian were formed, and meanwhile the pressure was accumulating for another thrust.

At last it came. The long pent-up force overcame the resistance. Another time of disturbance set in. Another part of the Archæan area was brought within the denuding force of the waves. Sand and pebbles were again formed, and the thickest

quartz-bed of the whole series was laid down. Judging by its effects this was the most extensive disturbance of the four. It formed a bed of sandstone reaching in some places a thickness of seven thousand feet, for the Catskill and the Pocono united sometimes surpass even these enormous figures. This implies immense erosion elsewhere, and the inference seems quite just that this Catskill-Pocono Ridge formed a conspicuous or an enduring feature in the Upper Devonian landscape.

But it disappeared and a time of inaction followed, marked by the deposition of numerous soft beds on the eastern sea-board and in the midland basin. These are now the Lower Carboniferous Rocks. Again the compressing force overcame its resistance and a fourth ridge arose, whose destruction in due course furnished the material of the Pottsville Conglomerate, underlying the Coal-Measures. The manufacture of quartz-sand and of pebbles again began, and a sheet of this material was spread over Western Pennsylvania, West Virginia, and Ohio, gradually diminishing in thickness and in size as it recedes from the parent reef. On this, when the stock of quartz was exhausted, were laid down the coal-beds, with all their intermediate limestones, shales, and sandstones.

Such, as I read it, was the history in brief of these four sandstones. I have omitted all details, all minor beds, and have touched only the great features of the story. Four acts in the drama are now complete, and the fifth and last follows in due course.

No trace remains of the four elevations above mentioned except the four monumental sandstones built up from their remains. But the case is different with the last. This was the great earth-thrust that occurred at the close of the Carboniferous period. Then the suspended force again came into action, and the newly-formed coal-beds were crushed and crumpled into the arches and troughs in which their remains now lie. Of this latest catastrophe abundant traces remain. The ridges then formed have not yet disappeared, and all the ranges of Pennsylvania, with the possible exception of the South Mountains, date their beginning to that event. This last act in the drama is one of the great facts in American geology. It is the greatest epoch in the history of the continent. The Appalachian Revolution closed the Palæozoic era and lifted North America above the waves of the ancient sea.

We need, therefore, only extend backward a known process to explain the origin of these four sandstones. We can in imagination see a series of ridges rising one beyond another in time gone by on what is now Eastern Pennsylvania. We see these ridges destroyed as, or after, they arose, and we see their wreckage forming new strata at a lower level. Extinct mountains, we may call them, which have passed away and left no trace on the face of the earth save the four great sandstones which form their monuments.

The wide plains of Eastern Pennsylvania were the standing-ground of these ridges. An extension of the quartzy strata of the South Mountains over this district where the mica-schists of the Archæan are now exposed, the successive crumpling of these strata and their subsequent erosion, complete the picture. Abundant material was obtainable, for we must be careful not to limit the area to its present size. Crumpling causes compression, and the site of Philadelphia must have then been much farther from that of Harrisburg than it now is.[1] The Archæan terranes east of the South Mountains were then deeply buried beneath later deposits since removed. Each successive area of crumpling from east to west became compressed beyond all further compression, and then added itself to the compressor, thus aiding to shove forward the adjoining area just as layer after layer of snow is added in front of a snow-plough until the resistance becomes great enough to stop the engine.

In the consideration of this subject the geologist is often puzzled to find a transporting force sufficient to distribute this sand and these pebbles over so great an area. From the ridges whence they were derived they have been strewn over the country to the westward for five hundred miles, in sheets of remarkable evenness, gradually thinning out as the distance from the quarry increases. The Oriskany is especially remarkable in this respect. It extends over the whole area above named, and over parts of New York, Maryland, and West Virginia, forming a bed of almost unbroken continuity, but seldom exceeding two hundred or three hundred feet in thickness. To what power can we attribute the formation of so thin and yet so broad a sheet?

Without dogmatizing on this difficult subject, there is one

[1] See American Naturalist for March, 1885.

suggestion which I wish to make. It may be of some use in explaining the phenomena, and it may not. I am disposed to attribute it to the tide, whose forced wave, sweeping every day over the successive ridges or through the successive archipelagoes which I have described, tore away the rocks and swept the fragments westward, rolling them over and over against one another until they were ground to pebbles and to sand. The tide-wave reaches the bottom of the deepest water, and is not a mere superficial current. Its motion is incessant, twice a day, and not occasional as that of the storm-wave. Finally, its direction in this region was westward, and it is a fact of no little significance, in this connection, that, so far as we can determine, all the material of these four sandstones has travelled westward.

These considerations united induce me to believe that the tide-wave was the chief agent in their formation; that, rolling, as it did, every twelve hours from the East into the midland ocean of North America, through the successive archipelagoes or reefs which I have here attempted to describe, it acted as a grinding and transporting engine of transcendent power to fashion and to carry the sand and pebbles of which our great conglomerates consist.

There is nothing, so far as I am aware, in the rocks that is incompatible with these views. It is well known that the conglomerates are thicker and coarser in the East than in the West, and that there also pebbles of slate and other softer minerals are more abundant. Only the very hardest material—the quartz—could survive the wear and tear of so long and so rough a journey, and accordingly in the West this material constitutes the whole mass of the rock.

One other point should be at least alluded to. Recent researches have rendered it probable that this great grinding engine, this tide-wave, was more powerful then than now; but on this I do not care to insist. Sir Robert Ball's immense six-hundred-foot tide-wave must, I think, be relegated to a much earlier date. Yet the theory is entitled to whatever advantage may be derived from the greater tides of palæozoic time.

Should the suggestions here made and the views here advanced, regarding the origin and formation of the Conglomerates of Pennsylvania, prove to be of any value, they may indirectly bear on the moot question of the antiquity of the Atlantic

Ocean; for, if the transportation of the pebbles and sand was really due to the tide, it would indicate the existence of an Atlantic basin in pre-palæozoic days, from which the forced wave flowed over or through these successive reefs or ledges into the midland basin.

THE PERISSODACTYLA.

BY E. D. COPE.

(Concluded from page 1007.)

THE CHALICOTHERIIDÆ had numerous representatives during Eocene time, and a few species of Chalicotherium extended into Miocene time. The boundaries which separate the family from the Lophiodontidæ on the one hand and the Menodontidæ on the other are not always easy to determine. From the former the symmetrically-developed external V's of the superior molars and the double V's of the inferior molars distinguish it; yet in Pachynolophus the anterior cingular cusp produces a part of the

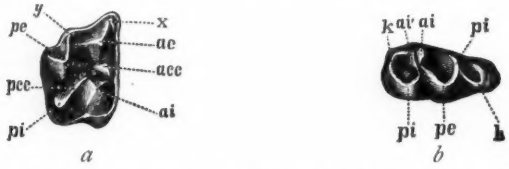
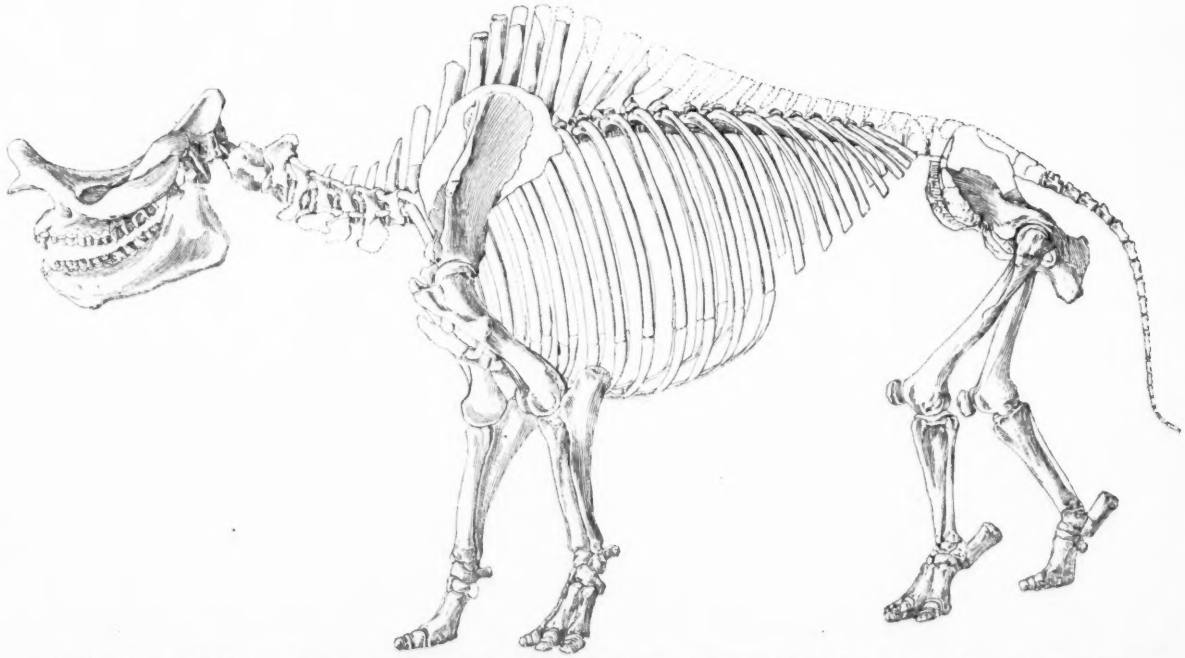


FIG. 24. *Lambdotherium popoagicum* Cope, molar teeth, natural size; from Wind River Eocene of Wyoming. From Wortman, after Cope. Fig. *a*, second superior molar; *b*, last inferior molar. *ae* and *pe*, anterior and posterior external V's; *y*, intermediate external rib; *x*, anterior external angle; *pi* and *ai*, anterior and posterior internal tubercles; *acc* and *pcc*, anterior and posterior intermediate tubercles; *h*, heel.

asymmetry found in the Lophiodontidæ. The character of the double inner cusps of the superior premolars, which distinguishes the Menodontidæ, is only found in the last premolar in Diplacodon of the latter, while a trace of the additional cusp of this tooth is found in the Chalicotheroid Nestoritherium.

In using the following table it must be borne in mind that the structure of the feet has not been determined in several of the genera:

PLATE XXXII.



Menodus giganteus Leidy, one twenty-fourth natural size; from White River (Oligocene) bed of Nebraska. From Scott and Osborn, in Bulletin Mus. Compar. Zoölogy, Cambridge, Mass.

I. Internal cones of superior molars separate from external lobes.
  A. External tubercles subconic, separated by a vertical external tubercle.
Fourth inferior premolar like first true molar;.....*Ectocium* Cope.
Third and fourth inferior premolars like the true molars;...*Epihippus* Marsh.[1]
  AA. External tubercles of superior molars become V's, which are separated externally by a vertical ridge.
  a. Incisors present.
  β. No diastema in front of second inferior premolar.
Second premolar without inner lobe; last molar with one inner cone;.....*Leurocephalus* S. & O.
Second premolar with inner cone; last superior molar with an inner cone;.....*Palæosyops* Leidy.
Second premolar with inner cone; last superior molar with two inner cones;.....*Limnohyus* Leidy.
  ββ. A diastema in front of second inferior premolar.
Two inner cones of last superior molar;.....*Lambdotherium* Cope.
  aa. Incisors absent from both jaws.
Last superior molar with one internal cone;.....*Nestoritherium* Kaup.

II. One or both internal cusps of superior molars united with the external lobes by cross-crests.
  a. External cusps of superior molars more or less conic.
An antero-external cingular cusp;.....*Pachynolophus* Pomel.
  aa. External lobes of superior molars, inflected V's.
  β. No crescentic inner lobes.
Intermediate lobes confluent;.....*Chalicotherium* Kaup.

FIG. 25. *Ectocium osbornianum* Cope, molars, natural size; from the Suessonian of Wyoming. Fig. *a*, superior molars; *b*, inferior molars. Original.

FIG. 26. *Lambdotherium popoagicum* Cope, lower jaw ramus, natural size; from Wind River Eocene of Wyoming. Original.

The phylogeny of this family is not difficult to read. Ectocium, if it be truly a member of it (the feet are unknown), is clearly the primitive genus, which is not far removed from Systemodon of the Lophidontidæ, in characters. The flattening of its external cusps produced the two external V's of the other genera, and this, without further modification, would give us Leurocephalus and Palæosyops, the former having the second superior premolars more simple than in the latter. This type,

[1] Teste Scott and Osborn.

with diastemata, is Lambdotherium. The same type, without incisors, gives us the Asiatic Nestoritherium. The development

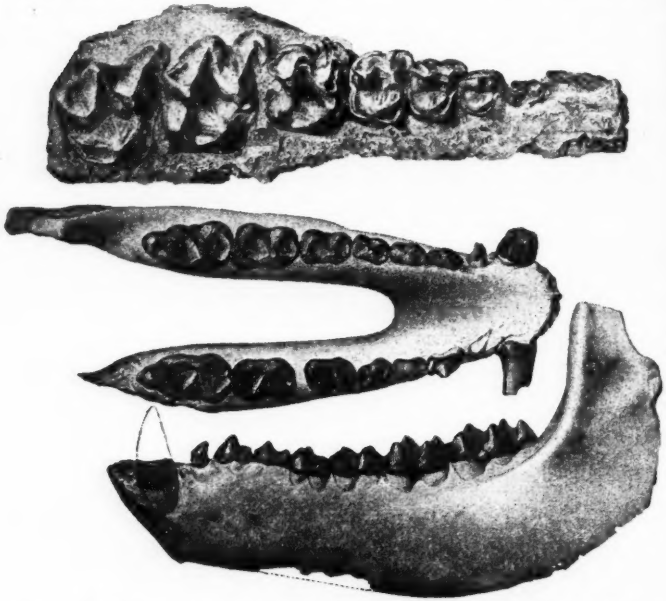


FIG. 27. *Palæosyops major* Leidy, superior molar teeth, one-half natural size; after Cope. From the Bridger Eocene of Wyoming.

of cross-crests is accomplished, as in other families, by the compression and fusion of the intermediate and internal tubercles. When the external V's are little pronounced, we have Pachynolophus; when they are well developed and the anterior inner tubercle remains distinct, we have the genus Chalicotherium. These relations are probably phylogenetic, and may be represented as follows:

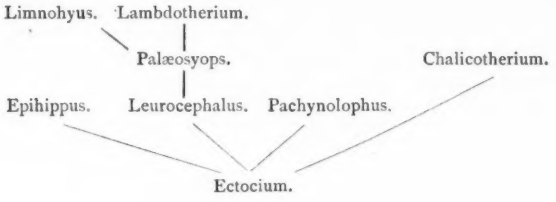
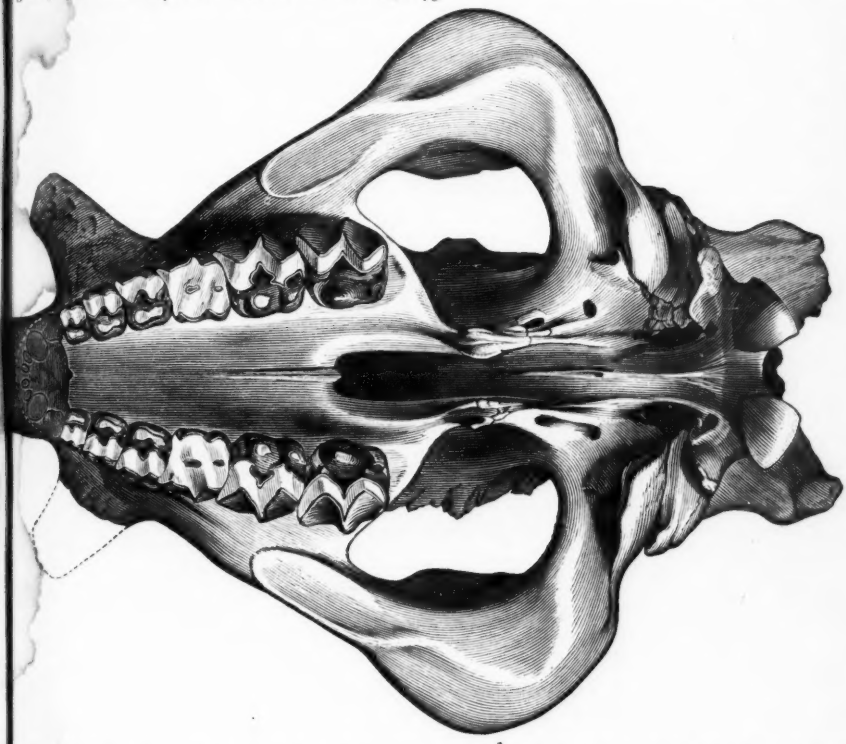


PLATE XXXIII.

a

(*a*) *Symborodon altirostris* Cope, skull, one-sixth natural size; from the White River Miocene of Colorado. Original; from Ann. Report U. S. Geol. Surv. Terrs., 1873.



b

(*b*) *Symborodon bucco* Cope, skull from below, one-sixth natural size; from the White River bed of Colorado. Original; from Ann. Report U. S. Geol. Surv. Terrs., 1873.

The known genera of MENODONTIDÆ are all American. They differ as follows:

a. Last superior premolar only with two inner tubercles.
Incisors present; no horns on the muzzle;.....*Diplacodon* Marsh.
aa. All the superior premolars with two interior cusps.
Six inferior incisors; canines very large;.....*Dæodon* Cope.
Six inferior incisors; canines very small; horns on the muzzle;...*Menodus* Pomel.
No inferior, and four small superior incisors; canine very small;
horns on the muzzle;.....*Symborodon* Cope.

Diplacodon, in its simpler premolars, approaches the Chalicotheriidæ, and is the oldest of the American genera. It is from the Diplacodon bed or Upper Eocene. Menodus and Symborodon, which include some species of gigantic size, belong in the White River or Oligocene, while Dæodon has, so far, only been obtained from the John Day or Middle Miocene. The phylogeny of the family is simple, as Diplacodon is clearly the ancestor of Dæodon on the one hand and Menodus on the other. Menodus in time, by the loss of its incisors, gave origin to Symborodon. This line left no representatives later than Miocene time. If Epihippus enters this family, it may be the parent of Mesohippus of the next higher horizon, the White River Miocene (Oligocene).

There are numerous species of the genera Menodus and Symborodon, and they are among the most remarkable of Mammalia. They are readily distinguished, among other characters, by the form of the horns. In one group of species they are round except at the tips, and are greatly elongated; in another they are sub-round or slightly compressed; in a third type they are short and trihedral; in a fourth type they are much compressed and expanded transversely; and in a fifth they are of insignificant size. Four of these types exist in both genera. They may be compared as follows:

	Group 1.	Group 2.
Menodus.....	*M. dolichoceras* S. and O.	*M. coloradoensis* Leidy.
		M. giganteus Leidy.
		M. tichoceras S. and O.
		M. angustigenis Cope.
Symborodon...	*S. acer* Cope.	*S. altirostris* Cope.
		S. bucco Cope.

	Group 3.	Group 4.	Group 5.
Menodus.....	*M. ingens* Marsh.	*M. platyceras* S. and O.	
Symborodon...	*S. trigonoceras* Cope.		*S. heloceras* Cope.

FIG. 28. *Symborodon acer* Cope, skull without maxillary and zygomatic bones, one-fifth natural size; left side; from White River beds of Colorado. Original. From Ann. Report U. S. Geol. Survey Terrs., 1873.

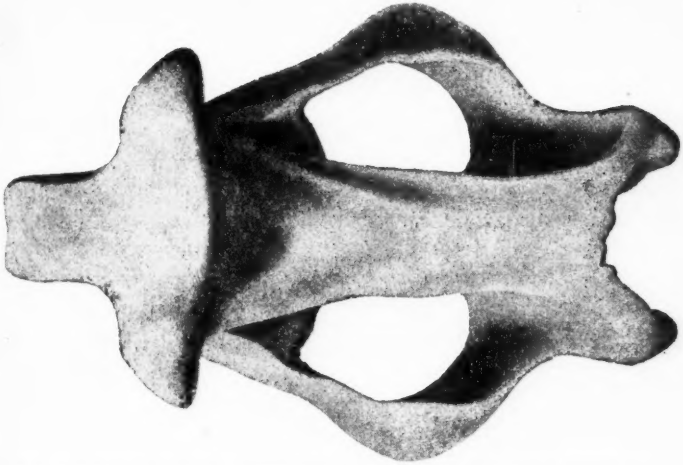


FIG. 29. *Symborodon trigonoceras* Cope, skull from above, one-tenth natural size; from White River bed of Colorado. Original; from "Report U. S. Geol. Survey Terrs." (unpublished).

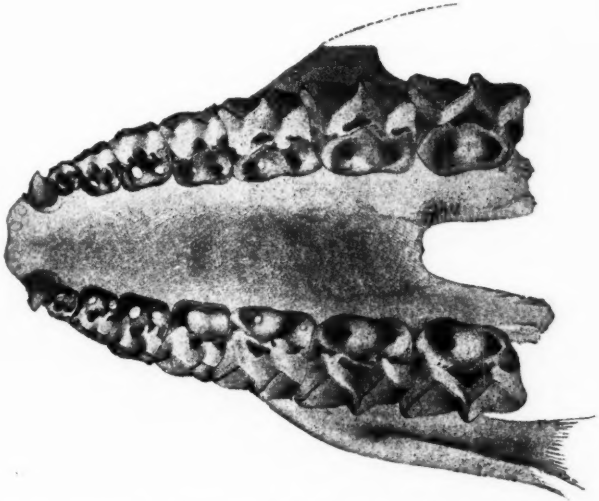


FIG. 30. *Symborodon trigonoceras* Cope, palate and teeth, one-fifth natural size; from White River bed of Colorado. From a different specimen from that represented in Fig. 29. Original; from "Report U. S. Geol. Survey Terrs." (unpublished).

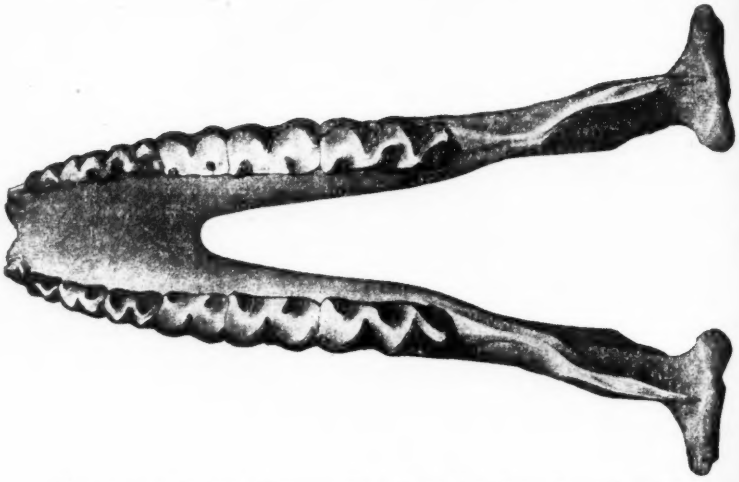
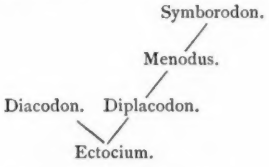


FIG. 31. *Symborodon trigonoceras* Cope, lower jaw from above; from White River beds of Colorado; one-fifth natural size. Original; from "Report U. S. Geol. Survey Terrs." (unpublished).

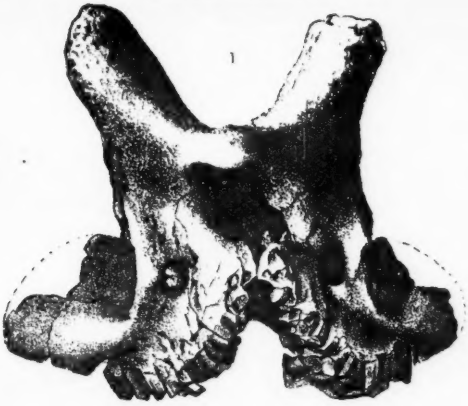
Transitional between the two genera is the *Menodus angustigenis* Cope, from the White River bed of Canada, which has the lower incisors of Menodus, with the narrow symphysis of the known species of Symborodon. The phylogeny of the family can be thus represented:

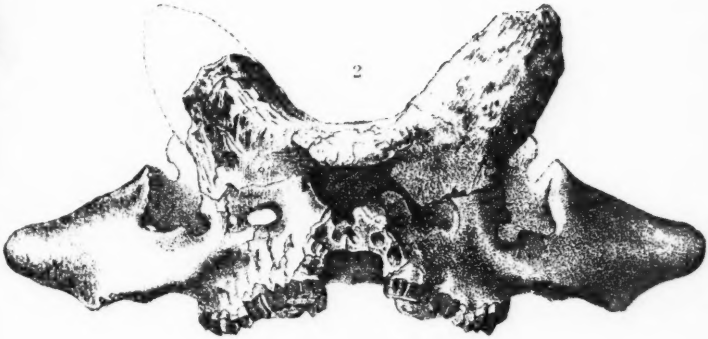


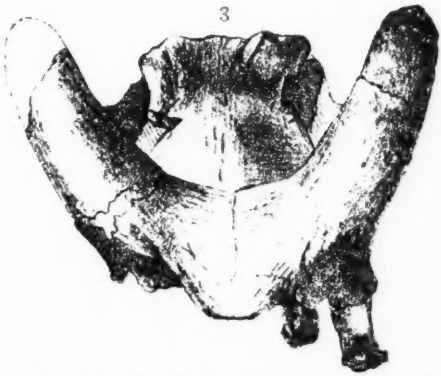
A genus, probably of this family, has been described from Transsylvania, under the name of Brachydiastematherium, but it has not yet been clearly distinguished from the known forms.

The PALÆOTHERIIDÆ embrace a greater number of forms, which fall into two well-distinguished divisions. In its complex premolar teeth, which in the upper jaw resemble the molars in composition, it shows an advance over the Chalicotheroid and other families of the Lower Eocene. In fact, it has not been found in the Lower Eocene, but commences in the Upper Eocene

PLATE XXXIV.







Front views of skulls of species of Symborodon, one-sixth natural size. Fig. 1, *S. altirostris;* Fig. 2, *bucco;* Fig. 3, *S. acer.* From Ann. Report U. S. Geol. Surv. Terrs., 1873.

in the genera Palæotherium and Paloplotherium. Thence it extends to the very summit of the Miocene, and may even occur in the European Pliocene (Protohippus). Its members exhibit considerable range of variation in the details of the teeth and feet, but no striking break of family importance occurs. The most noteworthy interruption is that which is found between the Palæotherinæ and Hippotheriinæ, where there is a change in the form of the proximal extremity of the humerus from a tapiroid to a horse-like form, and a modification of similar significance in the molar teeth, by the addition of a deposit of cementum.

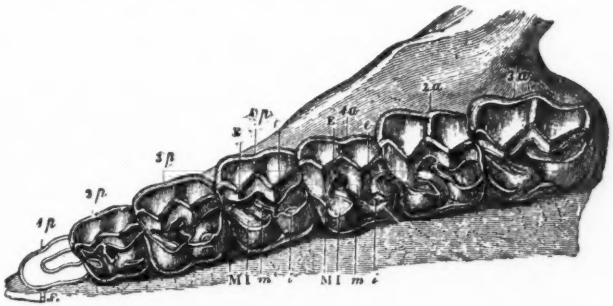


FIG. 32. *Palæotherium crassum* Cuv., superior molars from below, three-quarters natural size; from Gaudry. From the Upper Eocene of Paris.

The characters of the genera are as follows:

I. *Palæotheriinæ.* Bicipital groove of humerus simple; teeth without cementum.
  a. One or more internal tubercles of superior molars distinct.
    External V's of superior molars not well distinguished externally;.....*Anchilophus.*
    External V's separated by a vertical rib; intermediate tubercles not connecting fore and aft;.....*Paloplotherium.*
    External V's separated, intermediate tubercles extended fore and aft;.....*Anchippus.*
  aa. Internal tubercles of superior true molars continuous with the transverse ridges.
    Inferior molars with two V's only; lateral toes large;.....*Palæotherium.*
    Inferior molars with distinct internal tubercles; incisors not cupped;.....*Mesohippus.*
    Inferior molars with cusps at the inner extremities of the V's; incisors cupped;.....*Anchitherium.*
II. *Hippotheriinæ.* Bicipital groove of humerus double; molars with cement in the valleys. (Intermediate tubercles connected fore and aft; incisors cupped.)

a. One or more internal tubercles of superior molars distinct.
Inner lobes of inferior molars enlarged;.....*Hippotherium.*
aa. Internal tubercles of molars not distinct.
Inner lobes of inferior molars enlarged;.....*Protohippus.*

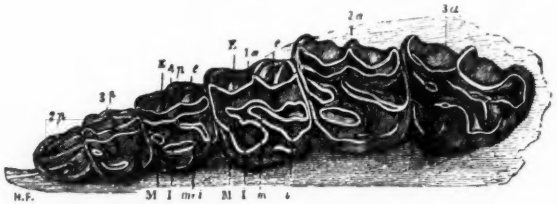


FIG. 33. *Paloplotherium minus* Cuv., superior molars, natural size, from below; from Gaudry. From the Upper Eocene of Lebruge.

Five genera of this family are European, and five are American. The Eocene genera are European only. Paloplotherium is found in the Middle Eocene, and is, as might have been anticipated, more nearly allied to the Chalicotheriidæ than any other genus of this family. Chalicotherium is not far removed from it. Anchilophus is Upper Eocene, and is allied to the genus just named, and also to Pachynolophus among the Chalicotheriidæ. These early genera constitute, by their similarity, the bond of connection between the three families, which, in their later and specialized forms, are very different from each other. Palæotherium is chiefly found in the Upper Eocene, and Mesohippus is only known from the White River or Oligocene, an age between Eocene and Miocene. Anchitherium commences in the Middle Miocene, and has Anchippus for a contemporary. In North America it remained, as late as the Ticholeptus epoch, in the *A. ultimum* Cope. Hippotherium existed only in the latter part of the Miocene epoch, consistently with the greatly specialized structure of its limbs and teeth. The nearly allied Protohippus lived with it, and in Europe a species with the same type of molar teeth is found in the Pliocene epoch (Forsyth-Major). These forms were

FIG. 34. *Palæotherium medium* Cuv., anterior foot, one-third natural size; from Gaudry. From the Upper Eocene of Paris.

contemporary with the Equidæ, which outlived them. They have many points of resemblance to that family, but, nevertheless, remain at a considerable interval from them in the structure of the feet.

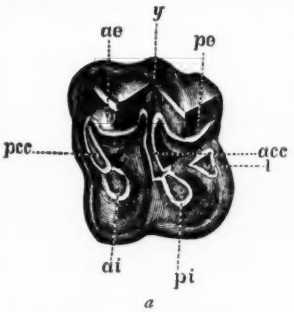


FIG. 35. *Anchitherium aurelianense; a*, superior, and *b*, inferior, molars, natural size; from the Miocene of France; from Gaudry, "Enchainements." Letters, *ae*, anterior external; *pe*, posterior external; *ai*, anterior internal; *pi*, posterior internal, cusps; *pce*, anterior intermediate; *acc*, median intermediate; *l*, posterior intermediate; *acc*, posterior intermediate, cusps; *k*, *h*, and *z*, oblique crests.

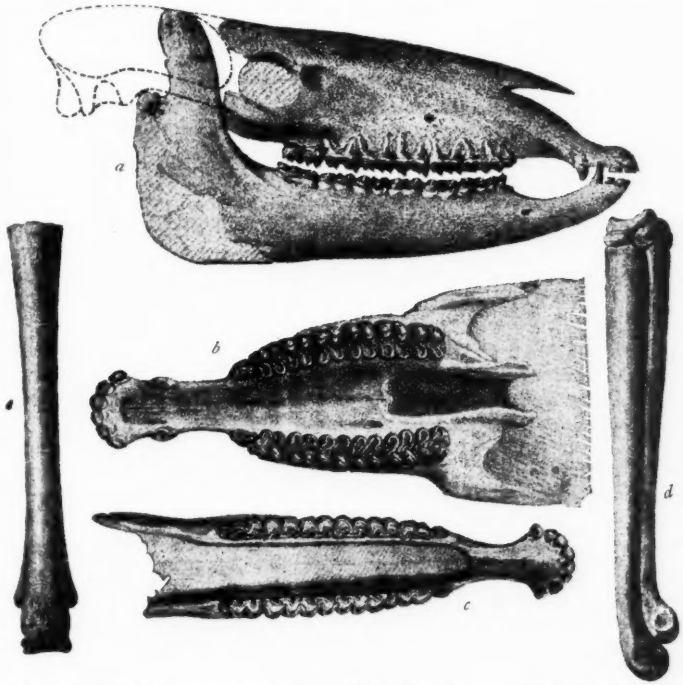


FIG. 36. *Anchitherium præstans* Cope, a little less than one-third natural size. Original; from the John Day (Middle) Miocene of Oregon. Fig. *a*, part of skull, right side; *b*, ditto from below; *c*, lower jaw from above; *d*, metapodial and part of tarsal bones from the inner side; *e*, the metapodials from front.

The phylogeny of the genera of this family is clearly, then, as follows: The genera with distinct internal tubercles must be regarded as primitive (Sect. I, *a*), and those with completed crests (I, *aa*) are derivative forms. The Hippotheriinæ are still later descendants on various accounts. First, the development of the intermediate tubercles is much greater than in any other genera. These tubercles are somewhat enlarged in Anchitherium (see Fig. 35, the anterior one), and they extend much further anteroposteriorly in Anchippus. In the Hippotheriinæ they reach and join each other at the middle of the crown (Fig. 40). In this transition the relations of the internal tubercles are various; for in Hippotherium, one of them (the anterior), remains distinct, while in Protohippus (Fig. 39) both are confluent with the intermediates. It may be

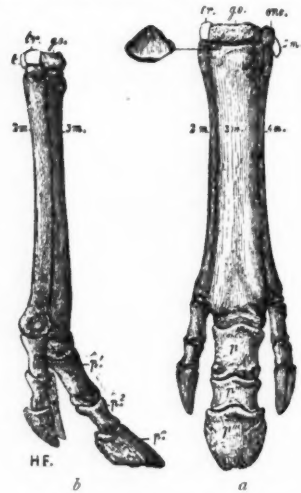


FIG. 37. *Anchitherium aurelianense*, anterior foot, less first carpal row, one-fifth natural size; from Gaudry. From the Miocene of Sansan, France. Fig. *a*, from front; *b*, from right side.

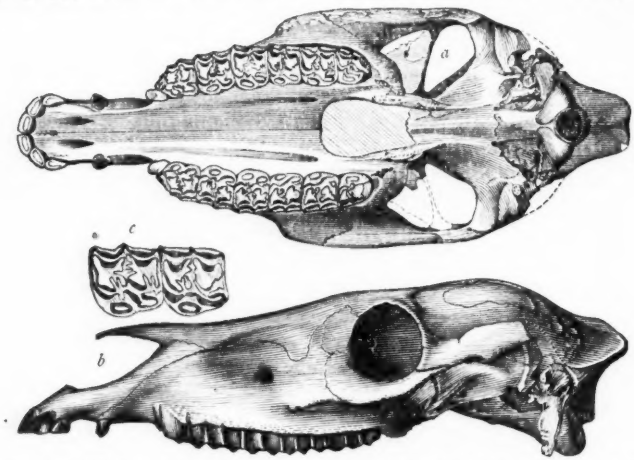


FIG. 38. *Hippotherium speciosum* Leidy, skull, from the Loup Fork bed of Nebraska, one-third natural size. Original. Fig. *a*, from below; *b*, left side; *c*, two superior molar teeth from below.

inferred from this that Hippotherium is a descendant of some genus of Sect. I, *a*, while Protohippus came from a genus of Sect. I, *aa*. The second point of modification to be observed in the Hippotheriinæ is the enlargement of the expansions of the internal extremities of the adjacent horns of the crescents of the inferior molars, which is

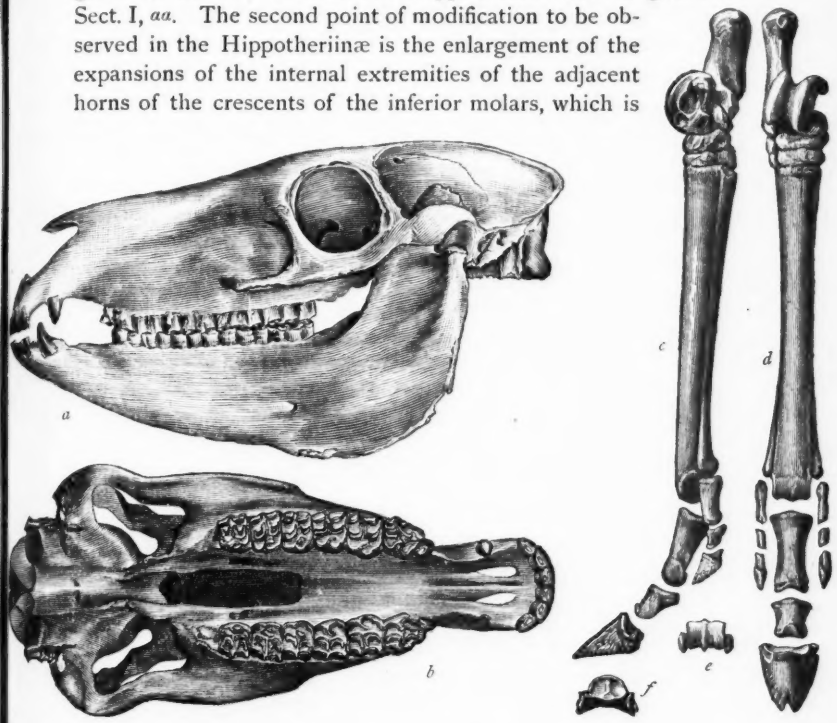


FIG. 39. *Protohippus sejunctus* Cope, one-third natural size. Original; from the Loup Fork Miocene of Colorado. Fig. *a*, skull, left side; *b*, ditto from below; *c*, posterior foot, left side; *d*, ditto, front; *e*, distal end of metapodials; *f*, proximal end of ungual phalange or hoof.

most obvious on wearing, and which are foreshadowed in Anchitherium (Fig. 35, *b*, *ai*, *ai'*). The third evidence of progress is seen in the deposit of cement, which fills the valleys of the teeth. Fourth, the two bicipital grooves of the humerus, which are identical with those seen in the Equidæ. Fifth, the cupping of the crowns of the incisors. This only commences with the genus Anchitherium, the otherwise nearly allied Mesohippus agreeing with Palæotherium and the genera of Sect. I, *a*, in the absence of the cup, as has been shown by Scott.

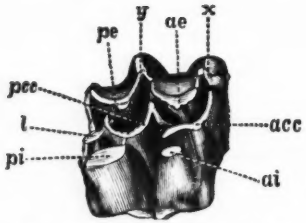


FIG. 40. Superior molar of Hippotherium from which the cementum has been removed, displaying the forms of the crests. From Kowalevsky.

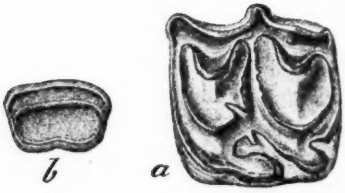


FIG. 41. *Hippidium spectans* Cope, teeth. Original; from Pliocene formation of Oregon. Fig. *a*, superior molar from below; *b*, incisor surface of crown, showing cup. Natural size.

These relations may be expressed as follows, in tabular form:

Hippotherium.	Protohippus.
Anchippus.	Anchitherium.
Paloplotherium.	Mesohippus.
Anchilophus.	Palæotherium.

*

Type with internal cusps and with fewer premolars like true molars.

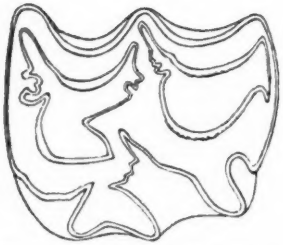


FIG. 42. *Equus crenidens* Cope, superior molar, pattern of enamel-ridges of crown. Original; from Pliocene epoch of Texas. Natural size.

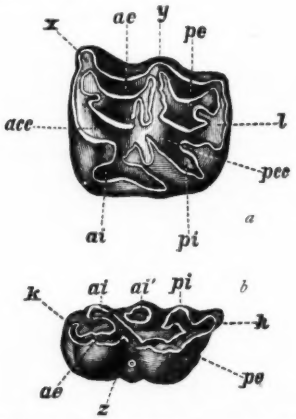


FIG. 43. *Equus caballus* L. *a*, superior, *b*, inferior, true molars. From Gaudry. Five-sixths natural size. Lettering as in Fig. 35.

The genera of EQUIDÆ are but two in number, and they are defined as follows:

Internal lobes of superior molars sub-equal; ..... *Hippidium.*
Anterior internal lobes of superior molars much larger than the posterior; ..... *Equus.*

The genus Hippidium is extinct, and its species have been thus far found only in North and South America, in beds of Pliocene and upper Miocene age. Equus made its appearance during the former period, and is represented by several existing species.

The Equidæ adds another evidence of greater specialization than the Palæotheriidæ in the structure of its feet,—*i.e.*, the distal metapodial keels are completed forwards, as in most ruminants. The mechanical cause of this extension remained, until recently, a puzzle to me. I have endeavored to show that the development of the tongue at the extremity of the metapodials of the Diplarthra was due to the impacts of the terminal phalanges often repeated, on hard ground, together with the compression of the surface on each side the keel by the flexor tendons with their sesamoid bones. But this did not account for the presence of the keel on the anterior face of the extremity. The instantaneous photographs of animals in motion by Muybridge have rendered the explanation easy. He shows that in Diplarthrous ungulates the phalanges are flexed at right angles *anteriorly* on the metapodials, at the last moment of rest on the ground before raising the foot for a new step. This movement is so quickly performed as not to be visible to the ordinary observer. This fact accounts for the late appearance in geological time of its effect on the end of the metapodial bone. I must add here that the acuteness and narrowness of the keel is partly due to the movement of torsion conveyed throughout all the bones of the feet at the moment of arrest by the ground, as referred to in the opening pages of this paper.

I must here describe another effect of torsion of the limbs at the moment of impact of the ungues with the ground, which I omitted from the proper place at the beginning of this paper. The proximal extremities of the metapodial bones are in most mammals extended inwards from the inner towards the outer side of the foot, so as to abut on the carpal or tarsal corresponding to the digit next external to them. This is due to pressure through

the carpals and tarsals of the second row or the heads of the metapodials, which is by the torsion turned from within outwards. The pressure thus applied has gradually pressed the heads of the metapodials outwards in the manner described. This effect began earlier than diplarthrism,[1] as it is seen in the Condylarthra.

In the preceding discussion of the phylogeny of the Perissodactyla the descent of genera within families has been described, and also the descent of families in their entireties has been discussed. The attempt to carry the line of generic succession across the boundaries of families has not been generally made. The lack of knowledge of such intermediate genera is the cause of this omission. Were such genera known, the definitions of the families would be less precise than they are. This complete phylogeny has been attempted, however, in the case of the genus Equus by various authors. The first suggestion was made by Cuvier, and the first arrangement of genera in the phylogenetic line of the horses was by Kowalevsky. His series commenced with Anchitherium, and had the other members Hippotherium and Equus. To this series Huxley added Palæotherium. Later, Marsh added two definite terms to the series, Hyracotherium and Hippidium, giving to both, however, new names (Eohippus and Pliohippus), and proposed two other steps (Orohippus and Miohippus), which were not sufficiently characterized to be since recognizable. The present writer determined the identity of the above forms, and added the still more primitive genus Systemodon. He also discovered and defined the Condylarthra, some of which, (Phenacodontidæ), he announced as the ancestor of all Perissodactyla, horses included.[2] Dr. Wortman followed, pointing out the double descent of the genus Equus from the two lines of Palæotheriidæ, and indicating the relations of species

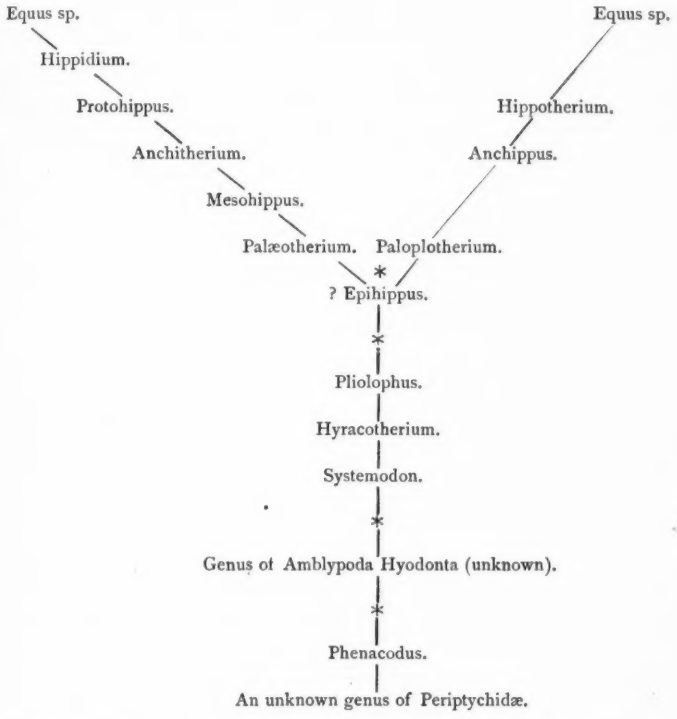
FIG. 44. *Equus caballus* L., manus, much reduced; from Gaudry, "Enchainements."

[1] Cuvier and Kowelevsky have shown that in the genera Sus and Dicotyles the head of the second metapodial is expanded inwards as well as outwards.

[2] Proceeds. Amer. Philosoph. Soc., 1881, p. 178.

of Equus to those of Hippotheriinæ.[1] Subsequently Scott pointed out the relation which the genus Mesohippus (Marsh) bears to the series. Schlosser followed,[2] throwing the Chalicotheriid and Menodontid genera out of the line into which they had been brought by Cope. In the present work the only change the author has made in his views is to return to his inclusion of the Menodontidæ in the line.[3]

As a result the following genealogy of the species of horse may be regarded as resting on the best evidence now available, as regards genera. It will be long before the line of species which has propagated itself to the present day, and appears in the *Equus caballus*, will be discovered.



[1] Revue Scientifique, 1883, p. 705. [2] Morphologisches Jahrbuch, xii., 1886, p. 31.
[3] Amer. Philos. Soc. Proceedings, 1881, p. 380; American Naturalist, 1886, p. 720.

It is certain, if the observation recorded by Mr. G. K. Gilbert is correct, that man was contemporary with species of Equus on the North American continent. I have identified[1] the remains of *Equus occidentalis* Leidy and *Equus excelsus* Leidy from the Upper Pliocene bed of Oregon, where they were mingled with obsidian arrow-heads and scrapers in a sandy bed easily disturbed by the wind. The contemporaneity of these remains being, under such circumstances, uncertain, it remained to discover them in a more solid deposit to confirm the suspicions raised by their association as first observed. Such a discovery is recorded by Dr. Gilbert as having been made in Nevada by a member of the United States Geological Survey. The *Equus occidentalis* thus shown to have been a contemporary of man, is not very close in characters to the true horse, but was proportioned more as in the ass. The head was as large as that of the horse, but the legs were more slender and a little shorter. It ranged from Oregon to Southwestern Texas, but its remains have not yet been found in the Valley of Mexico.

HORNLESS RUMINANTS.

BY R. C. AULD, F.Z.S.

(Continued from page 902.)

England, Wales, and Ireland.

IN treating of British cattle it is of interest to trace their origin. It may therefore be advantageous to quote the views of Prof. Boyd-Dawkins, especially as he has given the subject particular attention, and as I have had some correspondence with him in regard to polled cattle.

"The two principal stocks from which all the breeds are descended are undoubtedly (1) the Urus, an animal wild in the forests of Europe later than the days of Charles the Great, and which, so far as I know, was extinct in the British Isles before the historic period; and (2) the *Bos longifrons*, or 'small Celtic Short-horn,' an animal which never was aboriginally wild in Europe. Both were probably domesticated in Asia, and both make their appearance together in the Neolithic Age, in the

[1] Bulletin U. S. Geol. Survey, 1878, p. 389.

possession of farmers who lived on the wooden platforms and artificial islands in the Swiss lakes.

"The remains of the latter are to be found all over Europe in refuse-heaps belonging to various periods, from the Neolithic Age down to well within the historical frontier. It is the only domestic ox which I have met with in the large number of refuse-heaps in the British Isles, ranging from the Neolithic Age down to the time of the English invasion, and is represented by the present Highland cattle, small Welsh, and small Irish cattle.

"The first, or the Urus stock, preserved to us almost in its aboriginal purity in the so-called wild cattle of Chillingham, I am unable to trace farther back than the invasion of Britain by the English, and of Ireland by the Scandinavians. As the evidence stands, it was unknown in these islands as a domesticated animal before this time.

"The present breeds are, in my opinion, descended from the two stocks, and are the result of crossing and selection. The polled cattle I consider to be the result of selection, in which advantage has been taken of a tendency to revert to an ancestral hornless type, probably as far back as the Miocene Age. I should expect to meet with them from time to time in every breed, just as from time to time a horse is born with three toes, which have been derived from his remote Miocene ancestor, the Anchitherium."

He then refers to the case of the "breeding out of the horns in the Galloways" and the Gisburne polled cattle, on both of which points his observations are given in their proper place. The subject, however, of tracing the ancestry of all of the numerous British breeds, he says, he has as yet been unable to find time to deal with.

As supporting the view of the existence of the hornless character in the aboriginal races of cattle in Britain, there may be noted that certain foreign authors seem to have had evidence to that effect. Dr. Brocchi, in a most comprehensive and practical work,[1]—dealing first with *mammals*, in which come the various breeds of horses, cattle, sheep, and pigs common to France, or which have been introduced from other countries, with a description of their qualities and origin,—speaking of the *race Britannique*, remarks that the absence of horns characterizes this species of cattle. However true this may have been at one time, it is, as a

[1] "Traite de Zoologie Agricole, comprenant des elements de Pisiculture, d'Apiculture de Sericiculture, d'Ostreiculture, &c." Par P. Brocchi. Paris: Libraire, J. B. Baillière et Fils.

critic has remarked, "hardly correct, as a matter of fact, and is peculiar, to say the least," to-day. But if there had been a few more Marshalls among the breeders of Britain, it would, I believe, have been very true now.

Marshall, the celebrated authority, thus wrote (1780):

"There are already in this island three or four distinct breeds of hornless cattle; or rather, breeds of cattle many individuals of which are hornless. . . . These breeds are the old short-horned breed of Yorkshire; the Suffolk breed; a breed in Nottinghamshire propagated chiefly by the late Sir Charles Sedley, probably a variety of the Yorkshire breed [or of the White Park breed,—a herd of which is in this county]; and the breeds of Scotland, all of which, I believe, produce occasionally hornless individuals.

"The Galloways send out a breed almost wholly without horns, and some of them of good quality. Some of the Galloway cattle are not deficient in flesh. That of Nottingham has not come sufficiently under my notice to speak of its quality. For strong and middle-soiled districts there are individuals of the Yorkshire breed nearly perfect, especially for the purpose of milk and draft; as grazing stock the quality of the flesh may require some improvement. That of the Suffolk breed is well known to be of good quality. For lighter lands there may be superior individuals of the Suffolk breed in their present state sufficiently perfect for a basis at least. This breed has lately been used as beasts of draft in Norfolk with singularly good effect.

"I have digested my ideas, and I am clearly of opinion that . . . a breed of cattle answering nearly, if not exactly, the foregoing description will, in the nature of human affairs, become prevalent, if not common, to the Kingdom."

A prophecy that is likely eventually to become true, not only in Britain but in America.

Youatt divided the breeds of cattle of Great Britain, according to the comparative size of the horns, into five classes: (1) the *long-horns*, of the midland counties; (2) the *short-horns*, of the northern counties; (3) the *middle-horns*, of Devon, Sussex, Hereford, etc.; (4) the *crumpled-horns*, of Alderney and the southern coasts; (5) the *hornless*, or *polled*, of England and Scotland.

Polled Cattle among the Horned Breeds.—Any one must have observed that what Martin says is true,—

"Besides the polled cattle we have here noticed, varieties destitute of horns occur which confessedly belong to a horned race, and must not be considered as distinct. [He then notes the

Devon *natts* and Yorkshire polls.] The fact is, as we have before intimated, there are polled cattle of most breeds; the absence of horns is a mere accidental defect, rendered hereditary by the interbreeding of the cattle thus deficient; but these cattle, nevertheless, often exhibit a tendency to the development of their natural horns, and, indeed, show more than rudiments of them, so that it would be easy to extract a horned from a polled stock. Hence, then, we regard the distinction between polled cattle and others as arbitrary, or to be made only for convenience, unless there are other grounds of separation."

The Yorkshire Polls.—It is of importance to find that there exists a breed of polled cattle in Yorkshire described by all the early writers. Marshall, in his "Rural Economy," says,—

"In the North Riding of Yorkshire, at the commencement of the eighteenth century, the ancient black cattle were the only breed in the district. They resembled the present breed of the Lowlands of Scotland, mostly horned, but some of them humbled." (This is his "class 2," noted later on.)

Culley's supposition that they must have descended from the Galloway is untenable in the face of the existence of a county breed of polled cattle of much greater antiquity than the Galloway itself. I am supported here by the highest authority in Britain, among others, Mr. James Sinclair, editor of the *Live Stock Journal.*

What Culley says of the Yorkshire polls is as follows:[1]

"The polled or humbled cattle come next under our consideration, a kind well deserving of notice. We find a few of these straggling through different parts of England and Scotland. Among the rest, I remember Lord Darlington, not many years ago, had a very handsome breed of them finely globed with red and white."

Richard Parkinson[2] says,—

"Yorkshire polled cattle vary from the short-horned, already described, only in being without horns, which is a loss of about ten shillings a beast, as will be explained hereafter more fully. These cattle are generally handsome, and as good for the pail. There is a very conspicuous mark by which good breeds may be distinguished from bad,—namely, if the crown of the head be fine, like that of a doe, drawn almost to a point on the top, it indicates that the breed is good; this observation is worth notice in horned cattle. They require both richer food and greater age

[1] "Observations on Live Stock," by George Culley, 1786. [2] Live Stock.

than many other kinds to bring them to perfection, and are the most improper to breed on barren soils, badly sheltered, for such stinting would render them, in a very short space of time, small and coarse; and, as age is required, they suit best on situations a great distance from market, where part of the land is not good enough to fatten, but of a grazing quality, to keep stall stock in a growing, thriving state, and a portion sufficiently good to make them up for sale. Great numbers of these cattle bred in Yorkshire are fed on the fine rich marshes of Lincoln. But the best of them, both polled and horned, although of a good kind, are fattened at a more early age than their nature requires. Some of these large beasts are particularly fine on the crown of the head,—a point to which great regard ought to be paid in the choice of a bull, for several reasons. I have observed it to be a valuable symptom as to fattening; but from a general remark of the cow-keepers in London, a cow having the least appearance of a bull is a sure sign of her being a bad milker, therefore the finer the bull is on the forehead the more likely are his offspring to resemble him. Many cattle of these breeds have the worst hides,—so thin as to be deemed *paper hides*, which is a great fault. But it frequently happens that cows with these thin hides are only good for the pail: the best of them will give from thirty to thirty-six quarts of milk a day, from the time of calving till within three or four months of their calving again."

Parkinson has a good deal more to say under the above heading of "Yorkshire Polled Cattle," but he seems to fall away from those in particular to others in general. The crown of the head is twice referred to in the above. That *doe-headed* character is an interesting definition, as will appear: it might, *e.g.*, be easily contracted *doe 'ded.*

John Lawrence descants on them thus:

"The northern or Yorkshire polled cattle.—These have the same qualities as the short-horned cattle, carrying vast substance, and some I have seen lately are of great size, although in that particular they are most conveniently various. In my opinion they are a most excellent breed, and well merit improvement, with the view of labor, by a selection of the finest breed and most active individuals. From the shape of these polled cattle, they hold a strict affinity in all respects with the short-horned, among which they are found, and it seems that various breeds of horned cattle are attended with hornless but perfectly congenial varieties. The above, for example, and the polled Galloways of Scotland, of similar shape and quality with the long-horns, also the Devon natts, a polled cattle on the coast."

Having already quoted from Froude, I may be allowed to make another extract, as evidence of the reputation of Yorkshire for breeding fine cattle having existed from a very early date. The following is quoted in his History, vol. v. p. 45, from a manuscript instruction to the English general commanding an expedition into Scotland. After saying that biscuit, wine, and horse provender were to be lodged at Berwick, the order goes on that two hundred and sixty-two carts were to be requisitioned; and adds, "which may well be purveyed in York, where the great oxen be, and the best wains."

From a highly interesting table of the results of trials conducted between the years 1833 and 1865, by the king of Würtemberg, as to the milking propensities of various breeds, the polled Yorkshire is included along with the Friesian, Swiss, Durham, and polled Norfolk, and is described as "Reddish brown and white." From this table, published 1883,[1] it now appears that the polled Yorkshire was a recognized breed for the dairy.

The Devon Natts.—Associated with the Devon breed there are the Devonshire natts. Young, in his last tour, noticed them in the neighborhood of Barnstaple. Lawrence describes them as middle-sized, thick-set, and apt to make fat.

Youatt says of them,—describing them along with the West Somerset sheeted cattle,—

"They do not exhibit the true Devon color in these uncovered parts, for the hair is yellow instead of a deep blood-red, or almost brown color. In North Devon few of the North Devons are to be seen, but they are the same party-colored kind of which I have just spoken."

The meaning of the word *natt*, or *nott*, will be given in the chapter on Philology, which will be found of considerable scientific value in tracing *the origin* of these polled breeds.

The Polled Somersets.—Professor Low, in his "Illustrations of British Domesticated Animals," published in 1842, gives an illustration of "The Sheeted Breed of Somersetshire," which shows,—

1. Cow, of the polled variety, the property of John Weir, Esq., West Carnell, Somersetshire.

2. One of the horned variety, four years old, from the stock of the late Sir John Philips, Montacute House.

[1] In National Live Stock Journal.

Low describes them as "a variety of cattle rendered remarkable by the striking contrast of colors on the body, found in Somersetshire and the adjoining counties. It has existed in some parts of England from time immemorial. The red color of the hair has a light yellow tinge, and the white color passes like a sheet over the body. The individuals are sometimes horned, but most frequently they are polled. The cows are hardy, docile, and well suited to the dairy. The beef of the oxen is of good quality and well marbled. The breed has become rare, which is to be regretted, since it is much better suited to the dairy than others that have been adopted. The peculiar marking which distinguishes these cattle is not confined to any one breed. It appears among the cattle of Wales, where they are crossed by the White Forest breed, and is frequently among those of Ireland, and used to be so among the older Galloways of Scotland."

Again, in his other work, Low, in referring to their peculiar marking, gives some additional particulars as to this:

"It is common in Holland, where the colors are black and white.[1] It may be ascribed to the intermixture of two races having each a tendency to produce the pristine color of the stock from which it is derived. Thus a mixture of the White Forest breed and a Devon might produce an animal resembling the sheeted Somerset, with the Black Falkland one resembling the sheeted varieties of the Dutch, and so on. The peculiarity, when communicated, is very constant, and when two animals possessing it are mixed together in blood the progeny never fails to preserve the markings of the parents."

The peculiarity of a white body on cattle was years ago not uncommon in Aberdeenshire. I have seen several. In all cases the white was confined to the body. In Aberdeenshire they are called—when a cow, for example—*a blanket cow* or *a plaidit cow*, —one having the plaid about her. The white in Galloways seems to have gone along the back, and, like the Irish cattle, in patches.

Derbyshire Polls.—Arthur Young ("General View of the Agriculture of Hertfordshire," published in 1804) gives some brief notes upon the variety of cattle of that county. He mentions finding Devon, Hereford, Welsh, Long-horned and Short horn cows in milk, and in one place, Hatfield, the Marchioness of Salisbury had all these, "and buffaloes both of the whole and of

[1] The Dutch Belted breed has been introduced into this country successfully.

the half-breed crossed with Scotch and Devon, for veal and beef of fine quality." Here, as generally throughout Herts, the Suffolk cows were regarded as the best milkers. He also states that "Lord Grimston has the Spotted Polled breed from Mr. Mundy, of Derbyshire, and approves of the sort greatly." These Derbyshire Spotted Polls may have been descendants of the white wild cattle of that district of which Mr. Storer[1] speaks.

Among Herefords and Short-horns.—Mr. William Housman, the well-known English authority on live-stock matters, has written:

"I know at the present moment, in a Hereford family, a registered pedigree and of high reputation in the show-yard, a heifer with only scurs, as the modified horns sometimes found in polled cattle, and in cross-bred offspring of polled and horned breeds, are called in Scotland. They are little bits of flat horn, loose at the roots, so that you can twist them about, and quite hidden in a mass of hair, continued from a thick, long tuft, which grows upon a pointed crown-ridge, and falls over the forehead and sides of the head; and I have seen similar 'scurs' and top-knots on several female short-horns. In the case of all the short-horns which had them, I was enabled to trace descent, in some cases many descents, from 'grandson of Bolingbroke,' who was also the grandson of a polled and Galloway cow. In the single case of the Hereford I cannot trace any alien blood; but the pedigree is not a long one. Unless we take for granted an inseparable correlation of sugar-loaf skull and tufted head with the lack of horns, we can scarcely suppose these cases to be original sports. The thick top-knot and the pointed ridge of the skull would seem to bear evidence of a polled ancestor, to whose peculiarities, in other particulars than the mere absence of horns, the animal reverts."[2]

Mr. A. B. Allen, of New York, the well-known authority, commenting on Mr. Housman's remarks, said,—

"I have seen an occasional superb specimen of what might be called a muley short-horn in Northumberland, England. . . . There are thousands upon thousands of polled cows already in the United States."

The late Charles Stevenson, who was a juror at the 1857 Paris International Exhibition, states that "one bull was exhibited in the aged short-horn class, color white, whose head was adorned with small round knobs, not exceeding two inches in diameter.

[1] Wild White Cattle of Great Britain.

[2] National Live Stock Journal, October, 1882.

We have occasionally seen females of the short-horn breed with horns descending by the side of the head, and apparently not very firmly attached to the skull."

These facts should encourage short-horn breeders in their desire to raise an improved breed of *polled* short-horns.

Shakespeare was acquainted with the polled cattle. One would not have expected Shakespeare to have noted the polled character, nor in the manner he does; but the lover of sport in the forest supplies us with the following:

"*Beat.* Too curst is more than curst; I shall lessen God's sending that way, for it is said, God sends a curst cow short horns: but a cow too curst he sends none.

"*Leon.* So, by being too curst, God will send you no horns."[1]

This is rather a different attributive explanation than has generally been given.

Shelley is also another "famous writer" who seems to have been acquainted with hornless cattle; and later, Mr. Rider Haggard is acquainted with hornless oxen and goats.

In Wales.—Pennant[2] says,—

"Our native kind [of cattle], such as the Welsh and Scottish, are small and often hornless."

Wirt Sikes, a United States consul in Britain, gives a Welsh fairy legend,[3] in which there is evidently a reference to polled cattle:

"According to a legend current in Carmarthenshire, there was in days gone by a band of elfin ladies who used to haunt a lake in the neighborhood of Aberdovey. They usually appeared at dusk, clad in green, accompanied by their milk-white hounds and their droves of beautiful white kine. One day an old farmer had the good luck to catch one of these mystic cows, which had fallen in love with the cattle of his herd. From that day the farmer's fortune was made. Such calves, such milk, such butter and cheese as came from the milk-white cow had never been seen in Wales before. The farmer, therefore, soon became rich, and the owner of vast herds. One day, however, he took it into his head that the elfin cow was getting old, and that he had better fatten her for market. On the day appointed for its slaughter people came from all sides to see this wonderful animal; but as the butcher's bludgeon was severing its head a fearful shriek re-

[1] Much Ado About Nothing.—Act II., Scene 1.

[2] History of Quadrupeds. [3] British Goblins.

sounded through the air, and the astonished assemblage beheld a green lady crying with a loud voice,—

> 'Come, yellow anvil, stray horns,
> Speckled one of the lake,
> And of the *hornless* Dodin,
> Arise, come home.'

Whereupon not only did the elfin cow arise and go home, but all her progeny went with her, disappearing in the air over the hill-tops. Only one cow remained of all the farmer's herds, and, lo! she had turned from milky-white to raven-black. The farmer, in a fit of despair, drowned himself, and the black cow became the progenitor of the existing race of Welsh black cattle."

In Ireland—the Bogs.—Sir W. R. Wilde, M.D., has given some valuable details of the breeds of cattle of Ireland. He read a paper in 1858, published (1862) in vol. vii. of the "Proceedings of the Royal Irish Academy," entitled "On the Ancient and Modern Races of Oxen in Ireland." From it I quote as much as may be of interest:

"The animal-remains discovered in the great crannoge of Lagore, near Dunshaughin, county of Meath,—the first of the caverns or lake-fortresses which have been discovered during the last twenty years. The range of date of that crannoge has been fixed from A.D. 843 to 933. From these localities, as well as in deep cuttings made for the same purpose, and in peat-bogs, etc., other specimens of bovine remains have been deposited in the museum. I have selected twenty heads of ancient oxen, and arranged them in four rows, each row characteristic of a peculiar race or breed,—viz., the straight-horned, the curved- or middle-horned, the short-horned, and the hornless or maol, all of which existed in Ireland in the early period to which I have already alluded.

"According to my own observations, we possessed four native breeds about twenty-five years ago. First, the old Irish cow, of small stature, long in the back, and with moderate-sized, wide-spreading, slightly elevated, and projecting horns; they could scarcely be called long-horned, and they certainly were not short-horned. Their color was principally black and red. . . . Second, the Kerry, which is somewhat more of a middle-horn. Color, red, black, or brindled. . . . Third, the Irish long-horned, similar to, but not identical with, the Lancashire or Craven. . . . The fourth is the Maol or Moyle, the polled or hornless breed, similar to the Angus of the neighboring kingdom; called Myleen in Connaught, Mael in Munster, and Mwool in Ulster. In size they were inferior to the foregoing, although larger than the

Kerry, or even the old crook-horned Irish, but were comparatively few in numbers. In color they were either dun, black, or white, but very rarely mottled. They were not bad milkers, were remarkably docile, and were consequently much used for draught and ploughing."

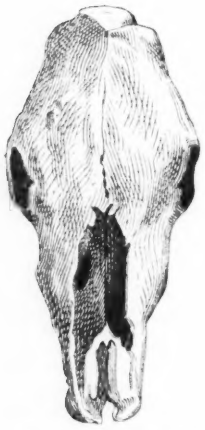
Describing each set of skulls corresponding to the above, of the polled Sir W. R. Wilde says,—

"The last is the Maol, or hornless, which differs so little from its living representative of the present day that it is unnecessary to describe it. From the five specimens placed before the academy, it is evident that it was much smaller than the modern breed. One head differs from another only in the amount of the occipital projection. The average length of the face is about seventeen inches, and eight inches across the orbits."

In a paper in the same volume, "Upon the Unmanufactured Animal Remains belonging to the Academy," Sir W. R. Wilde gives "a list of fifty-two ox-crania now in the museum."

"Nos. 48 to 55 are eight hornless, or maohl, varieties, and all except the two first present a very remarkable protuberance, a frontal crest, but this is especially marked in Nos. 50 and 53. As the maohl ox would appear to have abounded in Ireland more than in any other part of Europe, I subjoin the accompanying illustration of this hornless variety, which may be taken as affording a good idea of its general characters. It was accidentally omitted in my communication upon the 'Ancient and Modern Races of Oxen in Ireland.'" (Fig. 19.)

Fig. 19.



Proceedings of Royal Irish Academy. Fig. 14, page 211.

I am tempted to add the following, from Sir W. R. Wilde's first paper, referring to the state of the best breed in Ireland in olden times:

"The relics of our ancient oxen are not only abundant and interesting to naturalists, but are exceedingly curious in an historical point of view, as they afford undeniable evidence that, so far back as the eighth or tenth century at the latest, we had in Ireland a breed of cattle which, for beauty of head and shortness of horn, might

vie with some of the best modern improved races so much admired by stock-masters, and which are now being reintroduced from England."

Low and Youatt have long notes on this Irish breed:

"It is a variety scarcely known to the breeders of England, but which, from its properties, deserved far more attention on the part of the community where it has been naturalized. It has existed in Ireland from an unknown period, and appears to have been once widely diffused. It is now scattered throughout the country, and is only found in some numbers in the Vale of Shannon. They were of a light brownish color. They are superior in size to the Suffolk Duns, and equalling in this respect the larger class of short-horns. The breed has probably been formed by an early mixture of Dutch cattle with some of the native races. Had attention been directed to it at an early period, Ireland would have possessed a true dairy breed, not surpassed by any in the kingdom."

Of this ancient polled Irish breed the authors of the "History of Polled Aberdeen or Angus Cattle" quote from the *Irish Farmer's Gazette* in one of its August numbers, 1847:

"A relative of our own, deceased a few years ago at the age of one hundred and fourteen, had polled cattle in Ireland, and stated that the same breed had been in possession of his great-grandfather some two hundred years before our informant was born. These cattle were chiefly black, and black and white on the back; occasionally red, and brindled with white stripes; in some cases all white but the ears, which were red; and he believed there was never any intermixture of English or Scotch blood among them for the period he alluded to. They possessed the characters of being great milkers and good butter-producers."

Large importations of these Irish polled cattle arrived as late as 1750 at Port Patrick, in Scotland, and met a ready sale.

So late as 1826 these Irish polls seem to have existed. Andrew Henderson, son of one of the most extensive and spirited farmers of Dumfries-shire, thus writes of them ("The Practical Grazier," 1826):

"Several black or dark-colored ones are to be found, which, when brought to Dumfries market, are readily bought up by the Anandale jobbers, who soon convert them into Galloway cattle by mixing them with such lots and passing their word and honor as to the purity of the whole."

Youatt says the famous long-horns of England were derived from the Irish long-horns. What has become of all these famous Irish breeds? Mr. James Sinclair (already noted), in a recent paper on "Kerry Cattle," says that, "with the exception of the Kerry, all the native Irish races have become extinct, being crossed out by the short-horn." This is one great irretrievable loss, the cause of which has to be laid to the charge of the short-horn,—the loss of many of our finest old native breeds in various parts of Britain as well as Ireland.

Prof. P. McConnell, F.H.A.S., of Oxford University, also refers to these Irish polls or moylés in his "Agricultural Note Book," third edition, 1887.

Scotland.

In dealing with the polled cattle of Scotland I shall first give what Marshall and Lawrence have to say on the subject, and then detail the particular references to polled cattle discovered by original research, reserving some important points bearing on the wild white and the two black domesticated breeds for orderly treatment.

Mr. Marshall,[1] about the earliest general authority adducible, thus classifies the Scotch cattle driven from Scotland and fed in Norfolk in the end of the last century:

(1) Galloway Scots, mostly hornless, of a black or brindled color.

(2) Lowland Scots, some of them horned, some of them polled; their color black, or brindled, or dun.

(3) Highland cattle have in general, but not always, horns.

(4) Isle of Skys.

In the second class are included the breeds of a region—Caledonian—*three or four times larger* than the region of the Galloways. This it is important to remember, and it is most probable that a large proportion of the Scots sold in England as Galloway polled were really Angus and Aberdeenshire polled, for, as the writer on "Cattle of Great Britain" points out, it was simply on account of the propinquity of the district, thus being better known, that its polled cattle obtained in England the territorial term by which they became known, and hence also all Scotch polled cattle from whatever quarter, as they had to be driven

[1] Rural Economy of Norfolk, 1795, vol. i. p. 340.

over the same routes into England as the Galloways themselves.

The information of Marshall is derived from direct observation, hence it is of certain value.

John Lawrence thus treats of the subject:

"The Scottish Island, Mountain, and Lowland Cattle.—It is not improbable that there were only two original species of neat cattle in Scotland: those common to the islands and the mountain country, called kyloes; in color black, brindled, dun, brown, red; black being the favorite color in Scotland; in form flat and deep, like the short- and middle-horned stock, very small and hardy, with small, upright, short, or middle-length horns: and the polled breed, chiefly confined in latter times to the shire of Galloway, and known by that name. The former, the smallest and most hardy breed known in this island, and apparently the same with that of the more northern counties, may be seen at this day in its original purity, no motive existing for crossing a breed so perfectly adapted to severity of climate and scarcity of keep. The original polled cattle were of the same colors, but more varied, and considerably larger in size; in shape somewhat long, and resembling the long-horned species, with hides of considerable thickness; when these cattle are entirely hornless they may be presumed of the genuine breed. In the Lowlands, where the soil is abundant in provision, and where in consequence larger-sized cattle are supposed most advantageous, much crossing under the name of improvement has taken place. Thus the Scots polled cattle have been perpetually crossed with English bulls, both short- and long-horned, with Norman, and with their own mountain stock, whence the varieties of Galloway, Ayrshire, Fifeshire, and of the runts,[1] which are at this day found in Scotland." (Pp. 72, 73.)

The polled cattle of Scotland were known well enough apparently in France early in the century, for they had erroneous notions of them: "Même en Ecosse on trouve la race très petite, et fort souvent sans cornes."

I shall now detail various original evidences of the existence of polled cattle in Scotland, discovered in various unsuspected places.

"*Homyl*" *Cattle at the End of Eighth Century.*—Perhaps the earliest notice of the existence of polled cattle in Scotland to which a date can be assigned is that which may be found in Bellenden's "Hystory and Cronikles of Scotland." Buke x. c. 12, gives the "laws maid be Kenneth for the comonweil of

[1] See below: extract from "Hand-Book to Scotland."

Scottis." They refer principally to the domestic relation, and the twenty-first reads as follows:

"Quhen vncouth Ky fechtis amang thaym self, gif ane of thaym happenis to be slane, and vncertane quhat kow maid the slauchter, the kow that is homyll sall beir the wyte,[1] and the awnar thairoff sall recompens the dammage of the kow that is slane to his nychtbour."

"This," says a commentator on the passage, "certainly proceeds on the supposition that the animal slain exhibits no marks of having been gored."[2]

In Rev. Raphael Hollinshed's work the passage is thus rendered:

"If oxen or kine chance by running together to kill one another, the truth being not known which it was that did the hurt, that which is found without horns shall be judged the occasion of the skeath, and he that is owner of the same, shall have the dead beast, and satisfie him for the losse to whom it belonged."

The only comment to make is that the polled cattle of those days were credited with much vigor, and must have been very numerous.

Dr. Norman Macleod's Legend.—In the beautiful legend "The Spirit of Eld," given in his "Reminiscences of a Highland Parish," "three dun hornless cows" are prominently mentioned, and drawn in the accompanying illustration by Millais. This "dun" color was, according to Youatt, the usual color of the Highlanders' "fairy cattle." The mention of "hornless" in such legendary lore indicates a very early existence for polled cattle.

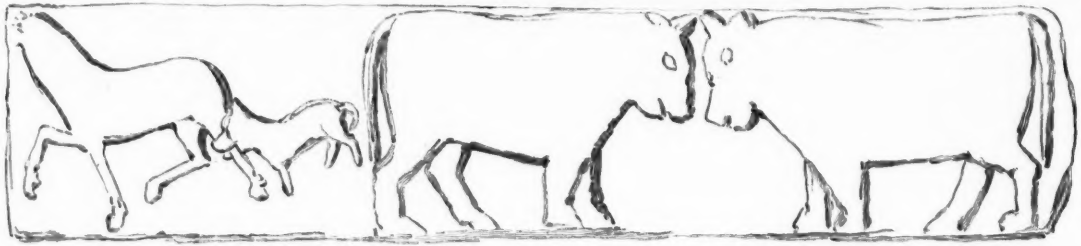
Polled Cattle on the Sculptured Stones of Meigle.—The age of these stones is given as dating from 900 A.D. to 1000 A.D., and may be seen in the old school-house of Meigle. The sculptured stone is figured in Plate LXXVII. of the Spalding Club's "Sculptured Stones of Scotland." The figures—as other representations of cattle in some of the same plates—are certainly meant for polled cattle.

A correspondent, Mr. William McCombie Smith, Persie, Blair-

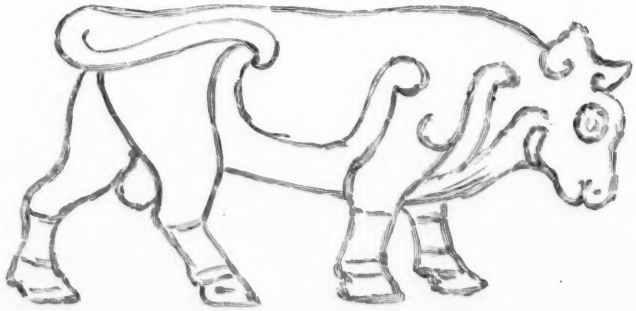
[1] For an illustration of the meaning of this, see "The Breed that Beats the Record," by the author, p. 60 (Aldine Co., Detroit, Mich.).

[2] Johnstone's Scottish Dictionary.

PLATE XXXV.



In minister's garden at Meigle. Plate 77. Spalding Club.



Spalding Club. Sculptured stones of Meigle at Inverness. No. 2, p. 38.

gowrie, walked "twelve miles in two and one-third hours" to examine these stones for me, and from the descriptions and impressions he made of them I am satisfied that they represent polled cattle. He reports that the natives regard the figures as representing polled cattle,—rather remarkable, as we might expect them to take the opposite view. This is strong testimony in their favor. The mention of homyl cattle about the same time, in the annals of Kenneth, who had his court not far from the same place, at this time, is also contributory evidence in their favor, and the sculptures may illustrate the combative tendency of the homylies of his time.

Evidence from a very Curious Source.—There is a most curious, quaint, and rare little book, preserved in the British Museum, entitled "A Modern Account of Scotland. Being an Exact Description of the Country, and a True Character of the People and the Manners. Written from thence by an English Gentleman. Printed in the year 1679." It is attributed to one T. Kirke. He gives an interesting peep into the state of the country at that time, but was strongly prejudiced against the people he visited. I quote the following passage from him:

"Their Cattle are only representatives of what are in other Countreys, these being so Epitomized that it is hard to know what class they relate to. Their Horses are hardy, and not without Gall (as some say other Horses are), using both tooth and nail to mischief you: that they may not use more state than their masters, they go Barefoot, which preserves them from the Gout; and if Hudibrasses Horse had been of this race, he had not needed a Corncutter. Their Furniture or Harness is all of the same matter, all Wood, from head to tail, Bridle, Saddle, Girths, Stirrups, and the Crupper, all wood; nothing but a Withy will bend a Witch, and if these be called Witches I shall not oppose it, since by their untoward Tricks one would guess the Devil to be in them; their Bridles have no Bits, but a kind of musroll of two pieces of wood; their Crupper is of a stick of a yards length, put cross their docks, both ends thereof being tied with woven wood to the saddle. Their Bed and Board too is all of the same dry Straw, and when they have it up, whip on Harness and away. Their neat are Hornless, the owners claiming sole propriety in these ornaments, nor should I deny them their Necklace too, for one thinks that twisted wood wou'd mightily become them. Their Sheep too have the same preferment, they are coupled together near their masters Palace. Some animals they have by the name of Hogs, but more like Porcupines bristled all over, and these are

likewise fastened to the Freehold by the former artifice; all their quadrupeds (Dogs alone excepted, in which sort they much abound) are honored with wooden Bracelets about their necks, legs, or arms, &c."

The first word cattle is here used in its original sense as given by the lexicographers. Todd says the term *chattail*, a provincial term, is used about Lyons, in France, for *all* the beasts of every kind on an estate. Johnson's definition of the word is "Beasts of pasture—not wild nor domestic." Richardson's definition is "Kine, horses, and some other animals appropriated to the use of man." Then we have the term *neat*. It is not accompanied by the word *cattle*, as it is in later forms, as *neat cattle*. It is used also in its original manner. It is the same as the English *nolt* and the Scottish *nowt*. The latter word, *nowt*, is still used in Scotland, by itself, to signify cattle, exactly as it is by T. Kirke. These facts are interesting, and are useful in explaining how afterwards kine and oxen had to be termed, generally, *horned cattle*, "to distinguish them from horses." This term horned cattle was used of beeves in England, whether they were long-horns, middle-horns, short-horns, or polled. But in Scotland, where cattle (neat) without horns had been as indigenous as cattle (horses) that never had such "preferment," the former were called "dodded," etc., "to distinguish them" from the latter.[1]

Sheep used also to be termed *small cattle*. While on this matter I may note here that I have seen the word *stot*, meaning a young ox, applied, in documents of the fourteenth century referring to certain Norfolk manors, to include horses. Among cattle-dealers of the present day the old term *beast* is used in the same sense as nowt in Scotland. The word *Beast* is the word still stereotyped on the bills of sale of the London salesmen to denominate cattle of the cow kind, and still pronounced *beece*.

I shall not venture further to explain the passage from T. Kirke, but along with the somewhat paradoxical case from Bellenden allow the reader to make his own construction. For us, however, the interesting fact remains that previous to 1679 A.D. the cattle of the Scots are stated by an observant traveller to have been hornless. Where had he seen them? or to what now existent race could the observation apply?

It certainly would not be in the south of Scotland that the

[1] Statistical Account of the Parish of Bendochy, 1795.

"English gentleman" wrote his account. It would be farther north. In a previous paragraph he writes:

"*Woods* they have none, that suits not with the frugality of the people, who are so far from propagating any that they destroy those they had upon this politic State maxim, That corn will not grow on the Land pastered about their humble conversation, that exceeds that of hornless Quadrupeds; marry, perhaps some of their Houses lurk under the shelter of a plump of Trees (the Bards not daring such a high presumption), like *Hugh Peter's Pass* in her Majesty or our own in an Ivy bush."

He was in the north, in a region where the "neat were hornless," where the country was bare of wood, etc. Where could so many marks of identity be found applying to any other district but *Buchan*, to which was applicable Dr. Johnson's (who passed through this region) not very correct remark of Scotland: "A tree might be a show there, as a horse in Venice," and which has been remarked by succeeding Sassanach visitors, as the "Druid," who wrote of the same district, that in 1820 "*Timberless* Buchan was great in 'doddies,'" meaning, possibly, to perpetrate a witticism on the character of the country and the cattle in it. At any rate, his observations would have been made in the Caledonian region.

The Dun Cow again.—In a book, "The Modern Husbandman," written by W. Ellis in 1750, is the following passage:

"I know a gentleman at this time that keeps the dun breed as a rarity for their particular color, small size, and their being polled, or without horns. These are of the Scotch kind, will live on a short bite, and milk better than some others of the same bigness. As they are hornless, they consequently will fat with lesser meat than the horned sort, and though the bull has little 'dub,' short horns (and the cows none), yet they are so small that it is out of his power to do mischief with them, and thereby the owner may depend on being free from the danger of being instrumental in shedding man's blood, which too many have brought themselves under by obstinately keeping a horned bull that they knew before to be unlucky."

In the North of Scotland.—Captain Burt, in his "Letters from the North of Scotland to his Friend in London," published 1754, vol. ii., letter xx., says,—

"I have several times seen them driving great numbers of Cattle along the sides of the Mountains at a great distance, but

never, except once, was near them. This was in a Time of Rain, by a wide River, where there was a Boat to ferry over the Drovers. The Cows were about fifty in Number, and took the Water like Spaniels; and when they were in, their Drivers made a hideous Cry to urge them forwards: this, they told me, they did to keep the Foremost of them from turning about; for, in that Case, the rest would do the like, and then they would be in Danger, especially the weakest of them, to be driven away and drowned by the Torrent. I thought it a very odd Sight to see so many Noses and Eyes just above Water, and nothing of them more to be seen, for they had no Horns, and upon the Land they appeared, in size and shape, like so many Lincolnshire Calves."

Noted by Pennant, 1769.—Pennant, in his tour, has noted the existence of polled cattle in Sutherlandshire, and, at an earlier date, noted that the Scotch cattle were "often hornless."

By Dr. Samuel Johnson and Boswell in 1773.—Dr. Samuel Johnson, in his tour in Scotland, passed through the Buchan district of Aberdeenshire, in 1773, on his way to the Highlands. When in Skye the doctor appears to have been particularly struck with the cattle and the manner of treating and marketing them:

"Of their black cattle, some are without horns, called by the Scots humble cows, as we call a bee a humble bee that wants a sting. Whether this difference be specific or accidental, though we inquired with great diligence, we could not be informed. We are not very sure that the bull is ever without horns, though we have been told that such bulls there are. What is produced by putting a horned and unhorned male and female together no man has ever tried that thought the result worthy of observation."

A worthy passage! As a sequel to it I quote a passage from the constant Boswell:

"This forenoon (November 4, 1773) he (Dr. J.) observed some cattle without horns, of which he seems to have taken notice in his journey, and seems undecided whether they be of a particular race. His doubts appear to have had no foundation, for my respectable neighbor, Mr. Fairlie, assures me they are a distinct species, and that when any calves have horns a mixture of breed can be traced. In confirmation of his opinion he pointed out to me the following passage in Tacitus ['De Mori et Pop. Germ. 5' (already quoted)], which he wondered had escaped Dr. Johnson."

It is impossible that in Skye the Scots called these hornless cattle *humble*. The only word they knew was *maol*. Hence the

doctor must have picked the word up from "the Scots" in other parts, as in Buchan, which he passed through.

References by Sir Walter Scott.—It is of great interest to note, as has already been done, what light our leading men of letters throw in their works on subjects of local investigation, when, especially, they held the traditions and antiquities in their minds so thoroughly. Luther, Shakespeare, and others had not allowed the natural character to escape their notice. By Burns this mention of polled cattle is conspicuous by its absence. This fact is the more remarkable, as he farmed for a time in Galloway. In one of the statistical accounts he is mentioned, not as being satisfied with Galloway cattle, but as introducing Ayrshires. It is passing strange that this natural character, which, as to proverb, lent itself so well to endearing use, should have not been utilized by him. We have failed to discover a reference by him. It is quite different with Scott. In "Old Mortality," chap. iv. (the date of the scene of which is about 1670), "the humle cow, the best in the byre of Niel Blaire," is recorded. This famous humle cow, note, had passed through several hands, and had been successively passed on to Niel through the hands of the drovers, she having come from the north. In "Guy Mannering," chap. ix., we find "Grizel chasing the humble cow out of the close." This scene opens with a description of Ellengowan, in Dumfries-shire, a conspicuous feature of which were "the green pastures, tenanted chiefly by herds of black cattle, then the staple commodity of the country," which cattle were (chap. ii.) "*Highland cattle.*"

In "The Two Drovers," chapter ii., is a colloquy between Mr. Ireby and a "Highland" drover, hailing from Doune:

"'And which peasts wad your honor pe for having?'—'Why—let me see—the two black—the dun one—yon doddy—him with the twisted horn—the brocket—How much by the head?'—'Ah,' said Robin, 'your honor is a shudge—a real shudge—I couldna have set off the pest six peasts better mysell, me that ken them as if they were my bairns, puir things,'" etc.

In the same chapter another drove is referred to by the same parties, together:

"'I passed another drove,' said the squire, 'with one of your countrymen behind them—they were something less beasts than

your drove, doddies most of them—a big man was with them—none of your kilts though, but a decent pair of breeches—D' ye know who he may be?'—'Hout aye—that might, could, and would be Hughie Morrison—I didna think he could hae peen sae weel up. He has made a day on us; but his Argyleshires will have wearied shanks. How far was he pehind?'" etc.[1]

In the same chapter is the following sentence:

"Ye ken, Highlander, and Lowlander, and Border men are a' ae man's bairns when you are over the Scots dyke."

How applicable is not the above to my contention as to the different Scotch breeds, on their crossing the Scots dyke? There was no distinction, all the horned Highlanders were Kyloes, and all the polled Lowlanders were Galloway, and Kyloes and Galloways were all Scots. Doune was in the centre of Caledonia, the region from whence class 2 of Mr. Marshall were drawn.

What influence was it that made doddies and humlies of so live an interest to Sir Walter? He was a personal friend and guest of Mr. Hugh Watson, Keillor, Forfarshire, the celebrated breeder of polled Angus cattle. It was undoubtedly from this association that Sir Walter got his knowledge of the polled cattle of his native country. Nowhere does he mention the term by which they became known—"Galloway"—in connection with cattle at all, though he uses this term in connection with the nags of that region; and no man was better acquainted with the border counties than he. He always uses the terms—to describe his polled cattle—by which were exclusively known the Angus and Buchan polls (*doddies* and *humlies*). From this it may be inferred that he knew that these descendants of the original polled cattle of Scotland were exclusively an appurtenance of the great Caledonian region.[2]

Rev. James Headrick, A.M. (first editor of the Highland So-

[1] To prove how early the cattle trade from the north to the south existed, I quote the following:

"In those days [about 1560 A.D.] a drover of the name of Rory, a wealthy man, and doing a large trade, was in the habit of lodging with Allancuaich [in Braemar] on his way to and from the south markets, after an unusually great sale and large profit at Amulrie." (Legends of the Braes of Mars. By John Grant, Glengairn.)

[2] See a paper by the author, "Origin of Scotch Breeds of Cattle," in Agricultural Gazette Almanac, 1887.

ciety's Transactions), author of the "Agricultural Survey of Angus-shire," published in 1813, writing twelve years later, said,—

"The polled are not confined to Galloway. I have frequently seen individuals without horns among the cattle in various parts of the Highlands and isles."

This is very important evidence. But, further, and even more interesting, William Aiton, author of the "General View of the County of Ayr," dated 1811, writes (p. 412), referring to the horns of the various breeds of cattle, "the breed of Mull have none."

John Smith, D.D., in his "Survey of Argyleshire," says of the cattle, "Few of them are polled;" which indicates that polled ones did, however, occur.

Obliteration of a Modern Polled Race—Fife Polls.—Youatt, p. 117, says,—

"A breed of polled cattle has also made its appearance in Fife, possessing all the good qualities of the horned, with even superior propensity to fatten, and much greater quietness and docility."

Professor Low, p. 333, says of them,—

"Extending from Fifeshire westward to the Ochil Hills, the cattle are generally hornless, and of a size intermediate between the breeds of the Highland mountains and those of the plains. Some of these cattle, especially those of the Ochil Hills, are really good, and suited to the country in which they are reared, and merely demand that attention to the selection of the breeding parents which shall call forth their more useful properties."

Mr. Dickson, in his work on live stock dated 1851, but which also refers to the beginning of the century, says of this polled breed, it is "unlike any others in Scotland;" it "is of good size and substance, and rather coarse, but equally suitable for shipping. Lays on flesh very well, and seldom deceives the butcher in weighing." Dickson ranks this breed as one of the "four distinct polled breeds in Scotland."

Of them the late Charles Stevenson, editor of the *North British Agriculturist*, wrote, in 1863,—

"At no very distant date there existed, extending from the west of the Ochils to the east of the Lomond Hills, in the county of Fife, a very valuable breed of polled cattle for the dairy. The colors were brown, brown and white, black and white. As dairy

stock, they were equal to the Ayrshire in quantity, while the quality was superior."

"*Highland Humlies.*"—In Mr. McCombie's early days "there was a race-starved vermin which were known by the name of 'Highland Humlies,' which I consider the worst of all breeds. No keep will move them much. At the top of these I must place those with the brown ridge along the back. They can be made older, but it takes more ability than I ever had to make them much bigger. Keep is entirely thrown away on them."[1]

The following extract officially and accurately summarizes the state of the polled breeds in Scotland in 1860. It is taken from the "Introduction—General View of Scotland," p. xiv. of Nelson's "Hand-Book to Scotland," by Rev. John M. Wilson, author of the "Imperial Gazetteer of Scotland":

"Three breeds of hornless cattle, the Galloways, the Angus humlies, and the Buchan, grazing the districts from which they take their name, together with contiguous ones, are known in the English shambles. A large-horned breed, called the runts, common in Fifeshire and Aberdeenshire, serve chiefly for salted beef."

The Angus and the Buchan polls have long been amalgamated, as they are radically of the same race, territorially belonging to the same geographical Caledonian region, so distinct and separate from the southern and Border region.

Curious Description of Orkney Cattle.—A manuscript of date 1529, in referring to the Orkney cattle, says . . . "the oxen be yoaked with cheats and haims and breachams, which they call weases, albeit they have horns." The last clause might lead one to suppose that the writer had only been accustomed previously to hornless cattle.

[1] Cattle and Cattle Breeders. 4th ed. By Wm. McCombie, of Tillyfour, M.P.

(To be continued.)

RECENT LITERATURE.

Sixth Annual Report of the U. S. Geological Survey.[1]— The sixth annual report of the survey under Major J. W. Powell is issued two years after the period to which it refers, and hence the accounts of progress which the volume contains are somewhat antiquated by the time they reach the public. This, however, is presumably the fault of the government printing-office, and not of the survey. Old as the news thus is, a few data may not prove uninteresting. The annual report for the fiscal year ending June 30, 1885, shows that the expense of the survey aggregated within a few hundred dollars of the appropriation of half a million. During the year, the topographical survey was completed and maps prepared for the engraver of fifty-seven thousand square miles of territory, at an average expense of three dollars per square mile. The usual administrative reports by the heads of the divisions appear in their. proper sequence, and from them we learn that in the future relief-cuts are to be used as much as possible in the illustration of the publications of the survey,—a decision which is to be commended when such good results are obtained as in the present volume. This will render it possible to use the same cuts over and over again when it is necessary, and also places electrotypes at the disposal of the survey. All of the heads of divisions, with one exception, enumerate their assistants, other than clerical, by name, and detail the work upon which they have been employed. A similar course in the other instance would give credit to several workers to whom it is certainly due.

The accompanying papers are five in number. Mr. L. F. Ward discusses the "Flora of the Laramie Group," and describes, from the leaves alone, many species of fossil plants. Mr. J. S. Curtis describes his modification of Plattner's method of quantitative determination of silver in an assay. The new apparatus described reminds one of the mechanical stages found on some microscopes. The three remaining papers need a much more extended notice than our space will allow.

In Southwestern Wisconsin is found an area of about ten thousand square miles which exhibits no traces of former glacial action, while all around it, for several hundred miles in every direction, all the phenomena of former glaciation are abundant. This was, as it were, an island in the great sea of ice which covered the whole northern part of the continent. Messrs. Chamberlain and Salisbury have been studying this driftless area, and their accounts are given in this report. They are, apparently, painstaking researches upon all the phenomena exhib-

[1] Sixth Annual Report of the United States Geological Survey to the Secretary of the Interior, 1884–85. By J. W. Powell, Director. Washington, 1885 [1887].

ited in the region, and, while one may not agree with all their conclusions, the paper will always have a value in connection with the question of several successive glaciations and of the formation of the loess. Their explanation of the cause of this driftless area is the same that has been advanced before,—a division of the continental ice-sheet by the high land to the north, and existence of lower channels to the right and left. This was supplemented by other influences the value of which it is difficult to estimate.

Professor Shaler's study of the phenomena exhibited by the sea-coast swamps of the eastern United States is also a valuable contribution to dynamical geology. The steps, as he traces them, in the formation of a salt-marsh are first, the deposit of mud by the currents in some sheltered spot, and next, the growth of eel-grass on the mud-flats thus formed. This in turn entangles still more mud, and soon the level is raised to where other plants can grow. This process is still further complicated by the formation of sand-beaches and sand-dunes, and of these two, or even more, may be formed in succession, broken here and there by openings for the drainage of the marsh behind.

Captain Dutton's paper on the "Geology of Mount Taylor and the Zuñi Plateau of New Mexico" gives the results of six years' studies in this region,—studies which are not easily reproduced in abstract, so strange is the region described. Here were found that peculiar type of volcanic action termed by Gilbert "laccolites;" dikes of volcanic material abundant around the edge of the plateau, but rare in its interior; carboniferous strata resting directly upon those of Cambrian age, and a series of mountain-peaks and necks not easily paralleled in other parts of the world, other than this strange western region which the past twenty years have shown to be so wonderful from every geological point of view.

Packard's Fossil Arthropods.[1]—Dr. Packard has for some time been engaged in the study of fossil arthropods, and in these two memoirs gives us the results of his latest studies, the outlines of which have already been presented in the pages of the NATURALIST. The Syncarida, a proposed new group, is assigned a place intermediate between the decapods and tetradecapods. To the reviewer it would seem that the forms included are true Amphipoda, and that "Syncarida" can at most have but family rank. A wider knowledge of existing amphipods would have

[1] "On the Syncarida, a hitherto undescribed Synthetic Group of Extinct Fossil Crustacea;" "On the Gampsonychidæ, an undescribed Family of Fossil Schizopod Crustacea;" "On the Anthracaridæ, a Family of Carboniferous Macrurous Decapod Crustacea;" "On the Carboniferous Xiphosurous Fauna of North America." By A. S. Packard Fifteenth and sixteenth memoirs of vol. iii. of the Memoirs of the National Academy of Sciences. 1887.

shown Dr. Packard that his definition and limitation of that group is extremely faulty. Dr. Packard's new family, Gampsonychidæ, is apparently valid, and belongs, where he has placed it, among the Schizopoda. In his paper on this group we observe that he regards his Syncarida as an ancestor of the schizopods. It is not easy to see how our knowledge of crustacean embryology supports such a view, for in development a schizopodal condition usually precedes the single-branched appendage. So far as the plates show, there is nothing except the telson to separate the family Anthracaridæ from the true Caridea, or to indicate that it differs from any existing group. The telson, however, is greatly different, approaching most closely in its appearance to that of the existing genus Euceramus of Stimpson.

The paper on the "Xiphosura of the Carboniferous" is the best of the series, containing as it does, in addition to the description of new forms, a *résumé* of our previous knowledge. It would seem, however, that the reference of *Cyclus americanus* to the genus Cyclus is hardly warranted. Except in the possession of a circular outline, Cyclus and the form in question have little in common. With regard to the other forms described or redescribed by Dr. Packard, but little needs to be said. The relegation of Euproops into synonymy seems warranted, but the sub-order Synziphosuridæ, with its four new families, should have, at most, but family rank. For the Merostomata and Trilobites Dr. Packard proposes a class, Podostomata, the definition of which could be very seriously criticised. The most prominent point, however, to be mentioned is that Dr. Packard, in this new group, actually renames one of his own groups, which in turn was well enough named before. A slight variation in the limits of the Gigantostraca of Haeckel and Dohrn makes this group synonymous with the later Palæocarida of Packard, while, so far as we can see, Packard's Palæocarida and Podostomata are absolutely identical.

In closing this review, we may call attention to a tendency on the part of our author to rename things already well named, and his pages fairly bristle with "arthrosome," "bænopod," "urosome," "cephalula," and the like,—all synonymous with previously-coined and widely-used terms. The learning of this new nomenclature, in order to read intelligently one of Dr. Packard's later productions, is, as suggested by Col. Theodore Lyman in another connection, extremely like sawdust-swallowing,—neither palatable nor nutritious.

Thomas on Mammalian Dentition.[1]—The reader who expects

[1] On the Homologies and Succession of the Teeth in the Dasyuridæ, with an attempt to trace the History of the Evolution of Mammalian Teeth in General. By Oldfield Thomas (British Museum). Philos. Transac. Royal Society, 1887, p. 443.

to find in this memoir a history of the evolution of Mammalian dentition will be disappointed, for it embraces only a history of the evolution of the milk-dentition and the nature of dental succession. To this end the author has written a very useful paper, and illustrates it with numerous instructive diagrams and figures. He first describes the dentition of the Dasyuridæ, and shows how the third, or, as he calls it, the fourth, superior premolar has disappeared, leaving but three in the genera Dasyurus and Sarcophilus. As Mr. Thomas calls the fourth superior premolar in the Marsupialia a true molar, he finds only two left in the genera named, and, believing that four premolars must be accounted for, he endeavors to show that another premolar has been lost in those genera. He concludes that the second is the missing one, and reaches this opinion by finding on one side of a single skull of *Phascogale dorsalis* a supernumerary tooth between the first and second premolars. In our opinion, this supernumerary tooth, if anything more than an abnormality, can only represent a former tooth of a series of five. Similar teeth have been observed in the inferior series in *Miacis edax* Leidy, and *Coryphodon latidens* Cope. It is quite unnecessary to complete the number of four premolars, since four are accounted for, after the replacement of the third, which is wanting in Dasyurus. The fourth is of molariform structure, and has been therefore regarded as a true molar by Flower and Thomas. The fact that it is in the genus Triïsodon and probably others (as Mioclænus, where there are four inferior premolars), shed and succeeded by a premolariform permanent tooth, is conclusive as to the homology, as I have pointed out.[1] Mr. Thomas finds my description of this genus "incomplete and confusing," and the reason why he does so is apparent from the above description of his views.

Mr. Thomas believes that the milk-dentition is not a remnant of a primitive succession derived from Reptilian ancestors, but holds, with Professor Flower, that it is a superaddition gradually introduced in the evolution of the Mammalia. The lack of milk-teeth other than the third premolar (or its homologue), from the Jurassic Mammalia, strongly supports this view. The fact that the temporary fourth premolar is in most placental Mammalia more complex than its permanent successor, is also in favor of this view, so far as it goes; and the fact that this complex tooth is permanent in the implacentals still further supports the opinion of Flower. On this view it appears that the placental has added to the implacental milk-dentition one tooth posteriorly and two anteriorly. It then looks as if the deciduous dentition consisted of primitive teeth retarded in their protrusion by more precocious ones. This is essentially Mr. Thomas's explanation,—which approximates that of Baume, who, however, differs in the method

[1] Final Report U. S. Geol. Survey Terrs., iii. Bk. i. p. 270, 1885.

of statement. Baume [1] regards the milk-dentition as expelled by the crowding of the germs of the permanent teeth in the jaws, and so caused to protrude earlier. The opinion of Thomas is preferable, since teeth of accelerated growth will certainly retard or repress germs of slower growth, and not weaker germs expel stronger germs, as Baume's theory requires. Moreover, milk-teeth appear at normal age for teeth, while the permanent ones are late. Mr. Thomas finds difficulty in accounting for such precocity and such crowding. Mechanical evolution furnishes the explanation. It is due to the shortening of the jaws; and this is a consequence of the development of the canine teeth from use, and the consequent forward movement of the masseter muscle and its insertions.[2]

It may be observed that the unnecessary terms Prototheria and Eutheria, which are generally ascribed to Professor Huxley in England, were really introduced by Professor Gill.[3]—*E. D. Cope.*

Jordan's Science Sketches.[4]—When Dr. Jordan undertakes the description of a fish his language is the language of science; when he turns his pen to the popularization of scientific subjects he still retains his former conciseness, but at the same time he manages to introduce many epigrammatic sentences and no little quiet humor, the latter the more enjoyable from the thoroughly natural manner in which it is used. His recent book, "Scientific Sketches," is made up of a series of articles, lectures, and addresses, most of which have appeared separately before, but which are welcome in permanent shape. Four of the sketches relate to fishes, dealing with the life of a salmon, the habits of the "John Darters," a sketch of the salmon family, and the dispersion of fresh-water fishes. Three are biographical sketches, the subjects being Rafinesque, Poey, and Darwin. The "Story of a Stone" is a bit of geological history for young readers; the "Ascent of the Matterhorn" is the least scientific, the "Nomenclature of Birds" the least popular, of the essays. The last essay in the volume, "The Evolution of the College Curriculum," is by far the most valuable, but to be fully appreciated it should be read in the light of the experiment in collegiate instruction which is being tried at the Indiana University, of which Dr. Jordan is the president. Dr. Jordan's idea is that a college should provide both the facilities for a general culture and also for detailed study; that, while teaching the elements of

[1] I only know this from Schlosser's description, Morphologishes Jahrbuch, 1886, p. 110.

[2] See Cope, The Mechanical Origin of the Sectorial Dentition, Proceeds. Amer. Assoc. Adv. Sci., 1887.

[3] Arrangement of the Families of Mammals, Smithsonian Contributions to Knowledge, 1872, pp. v., vi.

[4] Science Sketches. By David Starr Jordan. Chicago: A. C. McClurg & Co. 1887.

several subjects, it should give each student a thorough drill in some one branch. The scheme has been thoroughly worked out on paper, but time alone can tell how it results. It must be said, however, that it has amply satisfied its advocates during the two years that it has been tried.

Hepaticæ Americanæ.—The first twenty numbers (Decades I. and II.) of this distribution, by Dr. L. F. Underwood and O. F. Cook, were received in the latter part of November. The species represented are as follows, viz.: 1. *Riccia natans* L.; 2. *Marchantia polymorpha* L.; 3. *Conocephalus conicus* (L.) Dum.; 4. *Anthoceros lævis* L.; 5. *Blasia pusilla* L.; 6. *Steetzia lyellii* Lehm.; 7. *Frullania grayana* Mont.; 8. *Lejeunia serpyllifolia* Lib., var. *Americana* Lindb.; 9. *Madotheca porella* (Dicks.) Nees.; 10. *Radula complanata* (L.) Dum.; 11. *Ptilidium ciliare* (L.) Nees.; 12. *Bazzania trilobata* (L.) B. Gr.; 13. *Trichocolea tomentella* (Ehr.) Dum.; 14. *Lepidozia reptans* (L.) Dum.; 15. *Kantia trichomanis* (L.) B. Gr.; 16. *Geocalyx graveolens* (Schrad.) Nees.; 17. *Cephalozia curvifolia* (Dicks.) Dum.; 18. *Jungermania schraderi* Mart.; 19. *Scapania nemorosa* (L.) Dum.; 20. *Plagiochila porellioides* Lindenb.

The specimens are carefully selected, and are neatly labelled. As will be seen, they represent the four orders of Liverworts, as well as all the larger genera. The set is well worth the price asked for it ($1.25). It may be obtained of Dr. Underwood, at Syracuse, N. Y. Teachers of botany will find this set a valuable one for their beginning classes.—*Charles E. Bessey.*

GENERAL NOTES.

GEOLOGY AND PALÆONTOLOGY.

The Sonora Earthquake of May 3, 1887.—On the afternoon of May 3, 1887, at 2.12 Pacific time (=120° W. of Greenwich), the first of a series of earthquake movements was felt in the State of Sonora and the adjacent parts of Mexico and the United States, over an area extending from El Paso in Texas on the east to the river Colorado and the Gulf of California on the west, and from the State of Sinaloa on the south as far north as Albuquerque in New Mexico; the extremes in both directions being over five hundred miles. It was the fortune of the writers to be at the time at the great copper-mining camp of Bisbee in Arizona, in a narrow gorge of the Mule Pass Mountains, about five thousand three hundred feet above the sea, and near the border of Sonora. A violent tremor of the earth, including two sharp shocks, and lasting over ninety seconds, was succeeded at fre-

quent intervals by many lesser movements in the next three days, and less frequently at least up to May 29. In this part of Arizona solid house-walls, of *adobe*, or unburned brick, were cracked or overturned, while huge rocks in the steep mountain gorges rolled down, causing much damage. Fires, perhaps kindled by these in their course, appeared immediately afterwards in various wooded regions in Sonora and Arizona, giving rise to many false rumors of volcanic eruptions. The movement here seemed from south to north; the Sonora railroad track in one place near the frontier, running east and west, was displaced three inches to the north; while a chimney-shaft, without being overturned, was turned violently around upon its base. The small town of Bavispe in the Sierra Madre, in Sonora, was nearly destroyed, many people being killed and wounded. Opoto suffered in a similar way, and Fronteras to a less extent. The district chiefly affected by the earthquake is, however, for the most part a desert, with some cattle-ranches and mining stations.

Interesting studies were made by the authors in the valleys, or *mesas*, between the parallel mountain ridges in this region, both in the San Pedro and Sulphur Spring Valleys. The latter, lying to the east of Bisbee, and stretching north and south about one hundred miles, is often eight or ten miles wide, and has its lower portion in Sonora. Though without a visible water-course, water is there generally found at depths of from ten to forty feet in the numerous wells sunk at intervals to supply the needs of large herds of cattle. As described by many observers, the surface of this plain was visibly agitated by the first earthquake shock, so that persons were in some places thrown down by the heaving of the soil, which burst open, with discharges of water, while the wells overflowed and were partially filled with sand. In the southern part of this valley, for about seven miles south from the Mexican frontier, the authors found the results of the undulatory movement of the soil apparent in great numbers of cracks and dislocations. For distances of several hundred feet, along some lines with a generally north and south course, vertical downthrows on one side, of from one foot to two feet and more, were seen, the depressed portion rising either gradually or by a vertical step to the original level. Branching, and in some cases intersecting, cracks were observed. These depressions were evidently connected with outbursts of sand and water, which, along cracks,—marked by depressions on both sides,—sometimes covered areas of many hundred square feet with layers a foot or more in depth, marked here and there by craters two feet or more in diameter, through which water had risen during the outburst of these mud volcanoes. The authors examined many of these phenomena in Northern Sonora, and took photographs, which were exhibited. They note that while the

earthquake movements in the adjacent hills of Palæozoic strata had left no marks, the dislocations over many square miles in the valley would have sufficed to throw down buildings and to cause great loss of life in an inhabited region. There are believed to be no evidences of previous earthquake disturbances in this region since its discovery by the Spaniards centuries ago.

From the published reports of commissioners named by the State of Sonora it appears that the regions injured by the earthquake are in two nearly parallel north and south valleys in the district of Moctezuma, along the river Bavispe, a tributary of the Yaqui. The town of Bavispe itself, of fifteen hundred souls, lies about seventy miles south of the American frontier and one hundred and ten miles southeast of Bisbee, Arizona; its elevation being three thousand and seventy feet above the sea. Here forty-two persons were killed and twenty-five wounded. Bacerao, twenty miles farther south, also suffered much damage, and the estimate for property destroyed in this valley was two hundred and eighteen thousand one hundred and ninety-nine dollars. Opoto, Guasalas, Granados, Bacudebachio, and Nacovi lie in a lower valley about thirty miles west of the last, the elevation of Guasalas being only seventeen hundred and twenty feet above the sea. The loss of life was here confined to Opoto, where nine were killed and six wounded. The injury done to property in this valley was estimated at seventy-eight thousand one hundred and fifteen dollars. In both regions are noticed the opening, in the arable lands, of numerous fissures, generally north or northeast in direction, from many of which water flowed abundantly. The river thus supplied in a time of excessive drought swelled to the volume usual in the rainy season of summer; a condition which lasted up to the time of the report of Señor Liborio Vasquez, dated at Bavispe, May 29, 1887. The fields had become green and the air moist with prevailing fogs. A report concerning the region of Opoto mentions not less than seven volcanoes in the vicinity, which were seen burning for two days, but without any flow of lava; while that for the Bavispe region declares that no volcano had there been discovered. The authors incline to the belief that, as was the case in the San José Mountains, and others examined by them along the borders of Arizona, the appearances of volcanoes near Opoto were due to forest fires.—*T. Sterry Hunt, LL.D., F.R.S., and James Douglas, M.A., Brit. Assoc. Adv. Science, Manchester,* September, 1887. *Abstract.*

Crinoid Beds at Crawfordsville, Indiana.—The principal belt of bed-rock running through Montgomery County, Ind., belongs to the Keokuk group of the Subcarboniferous period: it is in this formation that the celebrated crinoid beds are situated.

Below the Louisville, New Albany and Chicago railroad-bridge,

on the north bank of Sugar Creek, section 29, township 19 north, range 4 west, is seen a high bluff of sandstone, which has been left exposed by excavation. This sandstone forms the roof of the crinoid beds and overlies the blue shale in which the crinoids are found. These beds were discovered by the late Prof. E. O. Hovey, of Wabash College, in 1836. He first noticed the shale, which seemed to be full of crinoid stems and shells; he collected a number of these and exhibited them to his classes in college, afterwards he called public attention to them.

In 1842, Horace C. Hovey, son of Prof. E. O. Hovey, began to collect these crinoidal fragments, and while he was thus engaged he found the first crinoid head found at these beds. This specimen was an *Actinocrinus.*

Mr. R. K. Krout and Mr. Ira Crane visited these banks in the year 1851, and collected quite a number of specimens. Mr. Crane found, in the ravine, one of the finest specimens of *Onychocrinus exsculptus* that has ever yet been found; this specimen was pictured in the *Scientific American* of July 12, 1887.

Mr. O. W. Corey was the next person to visit the banks. He was an excellent machinist, but nature seems to have intended him to follow the "bent of his genius" in digging crinoids. He found first impressions of crinoids in the sandstone. This led him to think that below this sandstone, in the blue shale, specimens might be preserved, so he at once set to work, dug below this sandstone, and opened up a bed of fossils that has never yet had an equal. His first collection was bought for Wabash College by Horace C. Hovey, who raised the money by solicitation. Mr. Corey then discovered other places near this bed, and opened them also. From his labors the beds bear his name, and are known as Corey's Bluff.

Yale College hearing of Mr. Corey's career, at once set Professor Bradley at work. Professor Bradley was then working for Horace C. Hovey, when he was engaged by Professor Marsh, of Yale College.

Charles Dyer, an Englishman, who lived near Cincinnati, came here, and bought specimens and shipped them to the British Museum.

The beds were then purchased by Professor Bassett, who has taken out many hundreds of fine specimens.

The following is a list of the species of the Crinoidea found at this locality:

1881. *Agaricocrinus springeri* White. Ind. Rep., 1881.
1868. *Barycrinus herculeus* Meek and Worthen (*B. hoveyi* var. *herculeus*). Ill. Rep., vol. v.
1861. *Barycrinus hoveyi* Hall (*Cyathocrinus hoveyi*). Ill. Rep., vol. v.
1859. *Batocrinus indianaënsis* Lyon and Cassiday (*Actinocrinus indianaënsis*). Ill. Rep., vol. v.

1880. *Batocrinus wachsmuthi* White (*Actinocrinus wachsmuthi*). Ind. Rep., 1879–80.
1869. *Calceocrinus bradleyi* Meek and Worthen. Ill. Rep., vol. v.
1868. *Catillocrinus bradleyi* Meek and Worthen. Ill. Rep., vol. v.
1865. *Cyathocrinus arboreus* Meek and Worthen. Ill. Rep., vol. iii.
1879. (?) *Cyathocrinus harrisi* S. A. Miller. Journ. Cincin. Soc. Nat. Hist., vol. ii.
1869. *Cyathocrinus inspiratus* (?) Lyon. Trans. Amer. Philos. Soc., vol. xiii.
1859. *Cyathocrinus multibrachiatus* Lyon and Cassiday. Amer. Journ. Sci., vol. xxviii.
1870. *Cyathocrinus poterium* Meek and Worthen. Ill. Rep., vol. v.
1860. *Dichocrinus ficus* Cassiday and Lyon. Ill. Rep., vol. v.
1860. *Dichocrinus polydactylus* Cassiday and Lyon. Proc. Amer. Acad. Arts and Sci., vol. v. Syn. *expansus* Meek and Worthen. Ill. Rep., vol. v.
1858. *Forbesiocrinus wortheni* Hall. Rep. Iowa, vol. ii. part ii.
1859. *Ollacrinus tuberosus* Lyon and Cassiday (*Goniasteroidocrinus tuberosus*). Amer. Journ. Sci. and Arts, vol. xxviii.
1859. *Onychocrinus exsculptus* Lyon and Cassiday. Syn. *Onychocrinus* (*Forbesiocrinus*) *norwoodi* Meek and Worthen. Ill. Rep., vol. ii.
1859. *Onychocrinus ramulosus* Lyon and Cassiday. Amer. Journ. Sci., vol. xxviii.
1865. *Platycrinus hemisphericus* Meek and Worthen (*Pleurocrinus*). Ill. Rep., vol. iii.
1870. *Poteriocrinus concinnus* Meek and Worthen (*Pot.* (*Zeacrinus*) *concinnus*). Ill. Rep., vol. v.
1870. *Poteriocrinus* (*Decadocrinus*) *depressus* Meek and Worthen (*Scaphiocrinus depressus*). Ill. Rep., vol. v.
1869. *Poteriocrinus* (*Scaphiocrinus*) *coreyi* Meek and Worthen. Rep. Ill., vol. v.
1878. *Poteriocrinus* (*Scaphiocrinus*) *gibsoni* White. Proc. Acad. Nat. Sci. Phil.
1879. *Poteriocrinus* (*Scytalocrinus*) *grandis* Wachsmuth and Springer, described as *Poteriocrinus coreyi*. Ill. Rep., vol. vi.
1878. *Poteriocrinus* (*Scaphiocrinus*) *gurleyi* White. Proc. Acad. Nat. Sci. Phil.
1865. *Poteriocrinus* (*Scaphiocrinus*) *Indianaënsis* Meek and Worthen. Ill. Rep., vol. iii.
1861. *Poteriocrinus nodobrachiatus* Hall. Bost. Journ. Nat. Hist., p. 614.
1861. *Poteriocrinus* (*Scytalocrinus*) *robustus* Hall. Bost. Journ. Nat. Hist., p. 315.
1879. *Poteriocrinus* (*Pachylocrinus*) *subæqualis* Wachsmuth and Springer. Ill. Rep., vol. v.
1861. *Poteriocrinus* (*Scaphiocrinus*) *unicus* Hall. Ill. Rep., vol. v.

1858. *Taxocrinus multibrachiatus* Lyon and Cassiday (labelled in most Amer. collections *Forbesiocrinus meeki* Hall). Amer. Journ. Sci., vol. xiii.

1861. *Vaxocrinus lyoni* Hall (*Cyathocrinus lyoni*) Meek and Worthen. 1868 (*Barycrinus lyoni*). Proc. Acad. Nat. Sci. Phil. Syn. *Cyathocrinus hexadactylus.—Chas. S. Beachler.*

The Carboniferous Genus Stereosternum.—The reception of a nearly entire specimen of the remarkable reptile *Stereosternum tumidum* Cope, from San Paolo, Brazil, through Professor Orville Derby, enables me to add a number of characters to those already known. The sternal region presents a large coracoid on each side posteriorly, and a transverse element anteriorly. Whether the latter is clavicle or the transverse limbs of a large interclavicle, is uncertain. The foramen of the humerus is *external.* The carpus consists of a radiale, a large intermedium, and a small ulnare; a large centrale and four tarsalia, the external related to two metapodials. The thumb is more robust than the four other digits. The neck is moderately elongate, and includes nine vertebræ besides the atlas. The vertebræ have robust transverse processes and slender cervical ribs. The skull is elongate and acuminate, and its bones are apparently fragile. Little of its structure can be made out. The teeth are slender, acute, and nearly straight, and are planted in (?) shallow alveoli.

The characters of the scapular arch differ from those of the Theromorpha. This character, with the different tarsus and rib-articulation, indicates that Dr. Baur's order Proganosauria, proposed for this type, is well founded. The lacertilian character of the ectepicondylar foramen of the humerus must be also remembered.—*E. D. Cope.*

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—In an exceedingly interesting paper recently published, Dr. A. Lagorio[2] discusses some of the fundamental principles relating to the nature of the glassy base of porphyritic rocks, the succession of crystallization in rock-magmas, and the classification of rocks. He emphasizes the thought that the geologist must ask the aid of chemistry and physics in solving the problems which present themselves to him. He must obtain all the light that these kindred sciences can lend him, and in this light must approach the hidden mysteries locked up in the depths of rock-masses, and must examine them with the critical eyes not merely of the geologist, but of the chemist and physicist as well. We may then, he thinks,

[1] Edited by DR. W. S. BAYLEY, Madison, Wisconsin.

[2] Miner. u. Petrog. Mitth., viii., 1887, p. 422.

obtain some knowledge as to the origin of rocks, their relations to each other, and the causes of the great variation in structure observed in them. The paper is full of interesting facts and valuable suggestions. It begins with a discussion of the theory proposed by Rosenbusch to account for the successive crystallization of rock-constituents. It has been recognized for a long time that the minerals in a rock did not crystallize in the inverse order of their fusibility, as might at first thought be expected. The order in which the separation takes place bears no relation to the temperature of solidification. Rosenbusch regards the acidity of the minerals as the important element governing their crystallization. He states, as a general law, that the order of the separation of the minerals from a rock-magma is inversely as their acidity. Roth[1] has called attention to the very many exceptions to this rule, and in its place gives seven empirical laws of association. Lagorio refuses to accept Rosenbusch's law, and proceeds to investigate the subject by chemical methods. He analyses the glassy ground-mass and crystallized portions (Ausscheidungen) of artificial and natural glasses, and thoroughly discusses the figures thus obtained. He finds that the *sodium-silicates* possess a stronger tendency to crystallize from a molten magma than do the corresponding isomorphous potassium compounds. Sodium is concentrated in the crystallized portions, and potassium in the residual ground-mass. With this discovery as his governing principle, Lagorio examined rocks varying widely in their composition and structure. Upon discussing the figures which these analyses yield, the following conclusions are reached: (1) A rock-magma is a more or less completely saturated solution of different silicates. (2) The normal glass—that in which all the other silicates are dissolved, or, more precisely, the last substance to crystallize from a molten rock or glass-magma—is a silicate of the composition $K_2O.2SiO_2$. This compound is capable of holding in solution silica, magnesia, lime, alumina, and iron-oxides, and from this solution the minerals separate out in a certain order, which is determined by the different amounts of the elements in solution and their affinity for each other, the sodium-bearing minerals always crystallizing before the corresponding potassium-bearing compounds. (3) The order of solubility of various compounds in the normal glass is: potassium compounds; sodium-silicates; calcium-, magnesium-, iron-salts; and, finally, oxides of the heavy metals, the latter being the most soluble. The greatest amount of supersaturation obtains in the case of the most soluble compounds. From such a supersaturated solution—a rock-magma—minerals separate in the order of the excess of saturation,—viz., the oxides of the heavy metals first, then the silicates of the heavy metals, then sodium-silicates, and, finally, quartz and the potassium-

[1] J. Roth, Chem. Geologie, ii. pp. 49 and 69.

silicates. (4) The stronger tendency of sodium compounds to separate, as compared with potassium compounds, is seen in the case of the sodium-bearing hornblendes and augites. (5) Sanidine crystallizes from a molten magma only after the relative proportions (molecular) of K_2O and Na_2O in it become as 2 : 1. (6) The affinity of the elements for each other is an important factor in determining the order of crystallization. Calcium and sodium are widely found associated in the same minerals, magnesium and sodium rarely. Potassium, on the other hand, occurs frequently with magnesium, rarely with calcium, etc. (7) The order of crystallization is as follows: Oxides, pure Fe-silicates, Mg-silicates, Fe + Mg-, Mg + Ca-, Mg + K-, Ca-, Ca + Na-, Na-, K-silicates, and, finally, silica, which latter, however, frequently separates out before or contemporaneously with the potassium-silicates. (8) The composition of a second generation of minerals in a porphyritic rock is dependent upon the composition of the residual magma at the time of their solidification, and not upon a recurrence of the conditions under which the corresponding minerals of the first generation were produced. (9) The more or less complete development of the constituents of the ground-mass of a rock is but slightly, if at all, dependent upon the rapidity with which the original magma cooled. In addition to these results obtained by a study of the composition of the different portions of a rock, Lagorio also discusses several theoretical questions of general interest. He believes that the hornblende and mica in rocks were formed in the presence of water[1] and under pressure. The existence of basic hydrogen in many members of the mica group, he thinks, would indicate this fact. He also criticises many of Rosenbusch's statements as to the origin of the plutonic rocks, which, Lagorio says, were originally eruptive or intrusive, but in their present condition are metamorphic. In conclusion, attention is called to the system of classification proposed by Rosenbusch[2] for the massive rocks, and some of the hypotheses upon which it is based are shown to have no foundation in fact. The paper, as a whole, is an admirable one, and bears evidence of care in its preparation. It is to be hoped that it will act as an incentive to more work in the direction of experimental and chemical geology.——In a late number of the *Quarterly Journal of the Geological Society* Mr. Rutley[3] has a paper on the rocks of the Malvern Hills, which, upon the occasion of its delivery before the society, gave rise to considerable debate. Mr. Rutley describes in detail the structure of the Malvern Hills, and gives two plates illustrating his views. The rocks of the range he divides into three classes,—eruptive, foliated, and stratified. The first consists principally of diorites, diabases, gabbros and granites, and felsites. These he describes

[1] *Cf.* American Naturalist, 1886, p. 160.
[2] Ib., February, 1887, p. 172.
[3] August, 1887, p. 481.

singly. The most notable fact in their consideration is the supposed occurrence of topaz in the felsite and the grouping of little crystals of this mineral in such a manner as to bring out the pearlitic structure of the rock. The second class the author "is inclined to regard . . . as probably being more or less altered volcanic tuffs, or as sedimentary rocks mainly composed of eruptive material derived from the disintegration of rocks of a dioritic or syenitic character." Various reasons are given for this conclusion, none of them, however, being based on petrographical evidence. The stratified rocks embrace tufas and quartzite.——Bergeron[1] mentions the occurrence of hyperite in the carboniferous of Aveyron, near the village of Arvieu. It contains intergrowths of hypersthene and diallage, in which $\infty P\infty$ of the hypersthene is parallel to $\infty P\infty$ of the diallage. The large crystals of hypersthene exhibit pressure effects to such a degree that the broken pieces of this mineral have been separated from each other, and between them have been injected portions of the granulitic ground-mass. The minerals comprising this ground-mass are round, and possess no crystal outlines. The smaller grains consist of pyroxene, which tends to group itself around the larger crystals of hypersthene, forming an aureole. The larger grains of the ground-mass are labradorite.——E. Cohen[2] has recently called attention to the fact that andalusite occurs much more frequently as an accessory mineral in normal granite than had formerly been supposed. He mentions five granites from the Vosges, Croatia, the Schwarzwald, and Vogesen, each of which contains more or less andalusite, but in quantity too small for isolation. In an aplitic tourmaline granite from Alt Zschillen, near Wechselburg, in Saxony, Cohen finds it in sufficient quantity for isolation, but not for analysis. The mineral occurs in isolated columnar and acicular forms, and not in groups, as in the case of contact rocks and the crystalline schists.

Mineralogical News.—After experimenting upon the effect of high temperatures on the optical properties of *faujasite* crystals, Rinne[3] concludes that this mineral is normally regular in crystallization. When exposed to the air it begins to lose water and becomes uniaxial, breaking up at the same time into eight individuals, each extending from an octahedral face into the centre of the crystal. These individuals are positively refractive, and their optical axes are perpendicular to the octahedral faces. When heated in contact with the air the difference between the index of refraction of the ordinary ray and that of the extraordinary ray becomes less and less as the temperature increases, until at 150° $\omega = \varepsilon$. At this temperature the mineral loses 16.83

[1] Comptes Rendus, cv., 1887, p. 247.
[2] Neues Jahrb. f. Min., etc., 1887, ii. p. 178.
[3] Ib., i. p. 17.

per cent. of water,—equivalent to twelve molecules. Above 150° the mineral remains uniaxial, but refracts negatively. When thin sections of the mineral are allowed to cool in the air they revert to their original condition of positive refraction, but if cooled under balsam (protected from the air) they remain negatively refractive. Faujasite, therefore, passes from the regular system to a crystallographic system of a lower degree of symmetry upon loss of part of its water. *Heulandite* from Andreasberg, on the contrary, is monoclinic under ordinary conditions. When heated to 150° it loses two molecules of water and becomes orthorhombic. It regains its original condition if submitted to the action of the atmosphere. This peculiarity of the Andreasberg heulandite is supposed by Rinne to be due partly to the large amount of strontium it contains, and its consequent approach in composition to brewsterite, which is known to possess peculiarities similar to those described. Jannasch, who has examined the heulandite from Andreasberg,[1] finds that it does in reality contain a large amount of strontium. ——Sandberger[2] thinks that, whatever might be the origin of *graphite*, it can certainly not have been produced in any igneous way. In studying Ceylon specimens of this mineral, he has discovered pieces on the $\infty P\infty$ faces of which are numerous little *rutile* crystals cutting each other at an angle of 60°, in the manner so frequently seen in mica. Had the temperature at the time of the formation of these crystals been high, he argues, they would have been reduced to the metallic state in the presence of such great excess of carbon. He also finds that many of the minerals associated with the graphite are covered with a coating of this mineral. Among the minerals thus covered may be mentioned quartz, orthoclase, mica, and apatite. Upon removing the outside shell of graphite from around the apatite, this mineral was seen to be marked with the outlines of the rutile needles imbedded in the graphite. This, says Sandberger, is an indication that the latter mineral was formed before the apatite had become hard.——In an article on the minerals of the Tyrol Cathrein[3] describes *grossularite* crystals, which, when broken open, are seen to consist of alternate zones of garnet and bluish calcite, of which the internal zones of garnet differ from the external zones both in color and composition. He examines also the so-called *paragonite* from Greiner (Zillerthal), and finds it to possess the ideal composition of talc. Cathrein also describes pseudomorphs of *fassaite* and *garnet* after gehlenite. The garnet pseudomorphs here described are the first known cases of the pseudomorphic origin of garnet. According to Klein and Jannasch,[4] the *ullmanite* (NiSbS) crystals from Löl-

[1] Neues Jahrb. f. Min., etc., 1887, ii. p. 39.
[2] Ib., p. 12.
[3] Miner. u. Petrog. Mitth., viii., 1887, p. 400.
[4] Neues Jahrb. f. Min., etc., 1887, ii. p. 169.

ling (Carinthia) and from Sarrabus (Sardinia) possess the same chemical composition. The mineral from Lölling, however, crystallizes in the inclined hemihedral division of the regular system, while the Sarrabus occurrence is parallel hemihedral. ——On *barite* crystals from the dolomite, near Volpersdorf, the four new planes $\infty\breve{P}5$, $3\breve{P}\infty$, $5\breve{P}\infty$, and $\frac{1}{4}\breve{P}2$ have been detected by Traube.[1]——Patton[2] studies crystallographically the *hornblende*, *oligoclase*, and *titanite* crystals in the druses of the Schriesheim diorite.——Igelström[3] describes the occurrence of braunite and hausmannite from the Sjögrube, in the Gouvernement of Oerebro, Sweden.——Ch. Lory[4] notes the occurrence of microscopic crystals of *albite* in various limestones and marbles from the Western Alps. Their origin, he thinks, is connected in some way with the specific nature of the calcareous deposits and with the conditions which produced their crystallization.

BOTANY.[5]

Character of the Injuries produced by Parasitic Fungi upon their Host-Plants.[6]—The first and most general injury which is produced upon plants by parasitic fungi results in consequence of the essential character of the fungus. Green plants have the power of converting inorganic materials into food for themselves. Fungi have not this power, but depend for their food entirely upon materials that have been previously elaborated by some green plant. Parasitic fungi take their food from their host while it is yet alive. The consequence to the plant, therefore, is a loss of food, a withdrawal of formed nutritive material, resulting, to greater or less extent, in starvation. In individual cells the contents usually suffer the greater injury, but the wall is also injured, as when penetrated by the haustoria, or suckers,—*e.g.*, upon the mycelium of Peronospora. But the special office of the haustoria is to absorb nutriment from the cell-contents. In some cases, as the above, the cell may live to be the continual prey of the parasite, and in some cases the cell is killed.

(2) While the food-supply of the plant is reduced, its power to replenish it is at the same time impaired,—*i.e.*, in case the fungus grows upon the green parts, as it does most frequently. The passage of light to the cells may be obstructed. The white moulds, or mildews, must obstruct it to some extent, black moulds growing over the surface, much more. The latter may occur either as true parasites, or as saprophytes upon "honey-dew."

Impaired nutrition weakens the physiological power of the chlorophyll. The life of the cells preyed upon is frequently

[1] Neues Jahrb. f. Min., etc., 1887, ii. p. 69.
[2] Ib., p. 261.
[3] Ib., p. 8.
[4] Comptes Rendus, cv., 1887, p. 99.
[5] Edited by Prof. CHARLES E. BESSEY, Lincoln, Nebraska.
[6] Read before Section F, A. A. A. S., August, 1887.

destroyed, and they become brown and dry, as in many species of Septoria, or crumble and fall out, leaving holes in the leaf, as frequently in *Puccinia asteris*. Where the injury is not so severe, spots of various colors, often characteristic of the species, mark more or less definitely the extent of the mycelium. Exposure to light and the activity of the chlorophyll may be lessened in another way, by a change in the position of the infested stems and leaves. A very common effect of a parasite is a more erect and rigid growth, as in blackberries diseased with *Cæoma nitens*, the orange-rust, and in the garden spurges, *Euphorbia maculata* and *E. hypericifolia*, infested with the cluster-cup, *Æcidium euphorbiæ*. These spurges normally grow prostrate, with leaves widely spreading, allowing the greatest possible exposure to sunlight. In the diseased condition the stems are erect and the leaves less favorably spread.

(3) Growth may be abnormally accelerated or retarded, and both these effects may be produced in different cases by the same fungus. *Peronospora parasitica* growing upon the common pepper-grass, *Lepidium virginicum*, forms a thick, felted coating of hyphæ upon the under surfaces of the leaves, and causes the latter to be somewhat contracted. The same fungus growing upon the stems of *Sisymbrium canescens* causes swelling and distortion. The Æcidium on *Sambucus canadensis* distorts the stem by accelerating growth, the infested side becoming swollen and the stem bent.

Exobasidium vaccinii on species of Vaccinium causes the leaves to shrink; forms believed to belong to the same species, growing on Azalea and Andromeda, produce inflated sacs, often several inches in diameter.

A distortion usually consists of the fungus producing it and the abnormal tissues of the host, as illustrated in the smut of maize and the curl of peach-leaves. In the latter extra layers of cells are formed on one side.

Æcidium euphorbiæ accelerates the growth of the stems of its host and retards that of the leaves,—an effect resembling that of insufficient light upon plants, as upon vines on the shaded side of a trellis, or potato-sprouts in a cellar. The orange-rust on blackberries retards the growth of the leaves, as does also the cluster-cup upon *Ranunculus abortivus*.

Fusicladium, the scab-fungus of apples and pears, retards the growth often of one side, while that of the other continues, producing unilateral development and curvature of the axis of the fruit.

(4) Fungi are not confined to the chlorophyll-bearing parts of plants; woody stems, roots, flowers, seeds, and fleshy fruits all have their parasites. One of the Myxomycetes, *Plasmodiophora brassicæ*, causes the disease called club-root in the roots of cabbage. The appearance of the club-root of roses, which is

troublesome in American green-houses, suggests a similar cause. Among those on woody stems are the black knot on species of Prunus and the Gymnosporangia on cedars.

The flower is attacked in the case of the "double blossom" of blackberries, the smuts of many grasses (such as *Ustilago rabenhorstiana* on *Panicum sanguinale*), and other cases that will suggest themselves. Often the entire inflorescence is arrested in its development. Smut of Indian corn attacks both staminate and pistillate flowers, and the green parts as well. *Ustilago antherarum* upon Caryophyllaceæ produces its spores in the anthers. *Tilletia caries*, the bunt of wheat, destroys the inner structure of the seed, without much changing the external appearance. The majority of Ustilagineæ attack the inflorescence, flowers, and fruit.

The young ovary is affected in various ways. Ergot distorts it and produces an abnormal, horn-like mass of tissue; smuts convert it into powdery spores. Exoascus changes that of Prunus into a pouch. Fusicladium kills the newly-formed pear.

(5) The last case is also an example of the premature falling of diseased parts, apparently by the formation of the separative layer before its time. Such a falling of leaves is well illustrated by *Septoria ribis* upon the currant. On the other hand, diseased parts may remain green after the other parts have matured in the usual way. Ovaries of *Eragrostis poæoides* filled with *Ustilago spermophorus* are most readily detected by this sign. Probably this may be classed as retarded development.

(6) Many fungi cause decay of ripe fruit, both while attached to its plant and after removal, while still alive. From a practical stand-point, the injury to fruit may be of two kinds; it may affect simply the appearance, and hence the market-value, or impair the quality, when it does not entirely destroy. The scab of apples is injurious in either of these degrees.

Some fungi begin their growth as parasites under ordinary conditions, to continue it under conditions more like those which accompany saprophytic growth; in this connection may be mentioned the potato-rot, beginning its growth upon the green plant and sometimes completing it in the cellar, but upon the still living tuber.

(7) Some valuable plants are liable to infection from others of less value; a knowledge of this fact in individual cases may be of great practical utility, as a remedy may be more easily and effectively applied. It is easier to destroy wild grapes and Ampelopsis than to destroy Peronospora upon cultivated grapes which have suffered infection from the wild ones. This remedy especially commends itself when one stage of the fungus grows upon one kind of plant and another stage upon another kind, as do cedar-apples and orchard-rusts.

Perhaps no line of investigation in economic mycology prom-

ises better practical results than this. The relations of a few of the Uredineæ are known, as are also the relations of Ustilagineæ and the yeast-like forms which may be looked for in manure; but of the life-histories of the great group of "Fungi imperfecti," including many injurious species, almost nothing is known.

It is often difficult to estimate the extent of the injury to be attributed to any one of these causes, as several commonly operate together. Canada thistle attacked by *Puccinia suaveolens* wilts in hot sunshine, while healthy plants remain fresh; and this appears to be due chiefly to the first cause, the loss of nutriment, which weakens the physiological power. Is it possible that the breaking of the epidermis by the sori, in this or other cases, increases the rapidity of transpiration?

Farmers say the red rust of wheat produces comparatively slight injury, while the black rust is destructive. The black rust appears on the stems, which at that stage of growth have little chlorophyll, even if healthy; the formation of winter spores appears to make a greater drain upon the resources of the host than the formation of summer spores, which have much weaker vitality.

Certain groups of plants are the prey of certain groups of fungi. Gymnosporangia grow upon Cupressineæ; Ræsteliæ upon Pomaceæ; Phragmidia upon the sub-order Rosaceæ proper. Numerous species of Uromyces are parasitic upon Leguminosæ, and the grasses support more Pucciniæ than does any other family of phanerogams. In these two genera no species is known to produce its teleutospores upon host-plants belonging to more than one order. The large majority of Uredineæ grow upon herbaceous plants, as do Ustilagineæ and Peronosporeæ. In these groups a given species commonly inhabits but few species of host-plants, while some Erysipheæ inhabit a large number.

Many Erysipheæ grow upon woody plants. Fungi imperfecti are perhaps least of all to be classified with reference to hosts, though many of their genera may be. Woody plants have fewer active parasites than herbaceous plants. Water-plants and those of wet places are freer from attack than those which grow upon common soil.

To recapitulate, parasitic fungi injure their host-plants by (1) depriving them of nourishment; (2) impairing the power of assimilation; (3) abnormally accelerating or retarding growth, causing distortion; (4) not only green parts are affected, but roots, stems, inflorescence, flowers, and fruit; (5) leaves and fruit fall prematurely; (6) decay is produced in ripe fruits before and after removal from the plant; (7) valuable plants receive injury from those of less value by ordinary infection or heterœcism.

The amount of injury due to one cause is uncertain, since several act together.

Certain groups of phanerogams are liable to be attacked by certain groups of fungi.—*A. B. Seymour, Cambridge, Mass.*

ENTOMOLOGY.[1]

Phengodini.—The AMERICAN NATURALIST for September, p. 853, contains an interesting account of some of the metamorphoses observed in *Phengodes laticollis* Horn., by G. F. Atkinson. From the descriptions of the form of the female, its mode of life, and also of the egg, is but a counterpart of all these stages observed in Zarhipis. Indeed, without more definite and microscopic details, the descriptions of these stages in Phengodes would do quite as well for Zarhipis, showing how close these genera are.

On page 855 the description of the egg of Phengodes appears, and it applies so well to that of Zarhipis as to make me think there are no differences in the eggs of the species of the two genera; though a microscopic comparison would most likely reveal distinctive characters, and which must be done by some one before an analysis of the Phengodini can be written. The eggs of Zarhipis are round, smooth, semi-opaque, tinged with yellowish; size, 4 mm. diameter. They are not much unlike small slugs' eggs. As the sexes are so much unlike in form, the next interesting point to discover is at what stage is the sexual character first perceptible. Mr. Albert Kœbele and myself have each a nursery of broods of larvæ of Zarhipis that have gone through one moulting, and they all maintain the same form, and which is very like their mother.

Mr. Atkinson, on page 855, says, "The luminosity in this case is of sexual significance, attracting the males at night." This is a good observation, which explains a certain mode in Phengodes, but it would not do to say that that is the method in Zarhipis, when its habit is known to be diurnal. Mr. Kœbele informs me that he captured two examples of a Zarhipis in the night-time, allured by an electric light in the city of Los Angeles. This observation would make it appear that Zarhipis is also nocturnal in habit. The composition of the powerfully-diffused electric light is so good an imitation of that of day that it can hardly be considered conclusive testimony, in the face of the known diurnal habit of the insect.

The two sets of observation would go to show, if they are both correct, that Zarhipis possesses the double habit of simply flying in the day and seeking at night, at which time there is burning a sexual lamp to guide it, which lamp is a beacon planted upon the goal it is seeking. Zarhipis does not visit our gas- and oil-lamps like other Lampyridæ, or, rather, has not hitherto been found to do so. The mysteries of the Phengodini are still many in number, and it is to the Lampyridists of the South we look for the unravelment of those of Phengodes, and we in the West have to look after Pterotus and Zarhipis.—*J. J. Rivers, University of California.*

[1] This department is edited by Prof. J. H. COMSTOCK, Cornell University, Ithaca, N. Y., to whom communications, books for notice, etc., should be sent.

Senses of Insects.—M. A. Forel[1] contributes a most interesting and exhaustive account of experiments made by himself and many others on the much-discussed problem of the senses of insects.

(1) In regard to the *sight* of ants, he notes especially these three conclusions: (*a*) They perceive light, and particularly ultra-violet (Lubbock); (*b*) they really see the ultra-violet rays, without eyes they are almost indifferent to them, and only respond to solar light more or less intense; (*c*) the dermatoptric sensations are feebler among the ants than in the animals which Graber studied.

(2) After reviewing new and old experiments as to the sense of *smell* in insects, he notes the following general facts: (*a*) In many insects which are essentially directed by sight, as in the Libellulids and Cicadas, the antennæ are rudimentary, and the sense of smell likewise. During the night these insects are passive, while during the day they trust to their power of sight, or possibly, in some cigalids, also to hearing; (*b*) the sensitive region, in spite of Graber's protestations, is situated in the antennæ, especially in those parts where the antennary nerve ramifies; (*c*) in certain insects, as in most Diptera, the antennæ serve almost solely for smelling purposes; (*d*) in other cases, however, where they are mobile, as in the Hymenoptera, they are used for detecting their food or their mates at great distances.

(3) As distinct organs of *taste*, M. Forel regards the nervous terminations (*a*) on the proboscis of flies (Leydig), (*b*) on the jaws and on the base of the tongue (Meinert), (*c*) on the end of the tongue (Forel), and (*d*) on the palate or on the epipharynx (Wolff).

(4 and 5) Forel's results as to *hearing* are, as yet, too negative to admit of notice. He finally discusses the sense of *touch* in its various manifestations, and the last chapter of his interesting memoir discusses the relation of the five senses to the general psychical life of insects.—*Four. Roy. Micr. Soc.*, 1887, p. 577.

ZOOLOGY.

Fresh-Water Sponges.—The *Proceedings* of the Philadelphia Academy of Natural Sciences for this year contain Mr. Edward Potts's monograph of "Fresh-Water Sponges." This paper contains, besides directions for collection and study, a translation of Vejdowsky's recent diagnosis of European Spongillids, a synopsis of all known North American species, and a *résumé* of all the known species of the world. The fifty-eight species are grouped in the genera Spongilla, Meyenia, Heteromyenia, Tubella, Parmula, Carterius, Uruguaya, Potamolepis, and Lubomirskia. The North American fauna embraces *Spongilla aspinosa*, *S. lacustris*, *S. fragilis*, *S. igloviformis* (nov.), *S. mackaya*, *S. novæ terræ*, *Mey-*

[1] Rec. Zool. Suisse, iv., 1887, pp. 161–240.

enia leidyi, *M. fluviatilis*, *M. robusta* (nov.), *M. milsii* (nov.), *M. subdivisa* (nov.), *M. baileyi*, *M. crateriformis*, *M. everettii*, *M. plumosa* var. *palmeri*, *Heteromyenia repens*, *H. argyrosperma*, *H. longistylis*, *H. ryderi*, *Tubella pennsylvanica*, *Carterius tubisperma*, *C. latitenta*, and *C. tenosperma*. Mr. Potts also describes as new *Parmula nesbyi* and *Meyenia minuta*, from South America. The paper is illustrated by eight well-executed process-plates of spicules, etc., of the species.

Arthropod Eyes.—The first number of Dr. Whitman's *Journal of Morphology* contains three articles dealing with the structure and growth of the eyes of arthropods. The first, by Dr. J. S. Kingsley, treats of the development of the compound eye of Crangon, an abstract of which appeared in the NATURALIST for November of last year. Dr. Kingsley claims that the compound eye arises as an invaginated pit of ectoderm, and that the retinal layers are inverted, the light traversing them in the same way as in the vertebrate retina.

The two other papers are by Dr. William Patten. The first, entitled "Eyes of Molluscs and Arthropods," is a summary of the results obtained by this author, and embodied in his longer paper in the *Mittheilungen* of the Naples Zoological Station for last year. The most important points brought out are that the whole of the so-called retinal elements of the compound eye are formed from a single layer of cells, and that this layer has not been inverted, as believed by Dr. Kingsley. He also shows that the rhabdoms of Grenacher are in reality formed by prolongations of the same cells which secrete the crystalline cones. According to his interpretations it follows that these eyes are not adapted for "mosaic vision," but that the nerve-fibres in the crystalline cones are the essential light and image percipient elements.

Dr. Patten's second paper deals with the development of the eyes of Vespa, and with some points in the structure of ocelli in insects. In the young embryos of Vespa the cephalic lobes present a thickening, which becomes pushed in and covered by an ectodermal outgrowth from the dorsal margin of the thickening. This thickening breaks up into at least six cords of cells, three of which ultimately enter into the formation of the optic ganglion, a fourth (dorsal to these) probably forms the antennal lobe, and the other two probably give rise to the mushroom bodies of the brain. While the foregoing steps are in progress a second thickening arises below the first, and sends inwards a process which forms the optic nerve. Then a shallow pit appears in the outer surface, and this becomes enclosed by a growth of ectoderm over it, so that this portion, which eventually forms the eye, in reality consists of three layers, the inner furnishing the retinal elements, which are erect, and not inverted as mentioned above in Crangon. Dr. Patten traces the development of the optic lobe from

the three cords of cells already mentioned, as well as the formation of the nerve-fibres and the inner and outer medulla. Besides this, he gives, but with less detail, the history of the retinal—or, to use the term with his significance, ommatidial—elements. In their history he agrees well with Dr. Kingsley.

Dr. Patten's paper contains a number of other observations. He shows that the median ocellus of Vespa arises as two ocelli, which later become fused together, while some points in the development of the compound eye (not mentioned here), as well as in the simple eyes of beetles, seem to prove that the compound eyes have arisen, not by a coalescence, but by a division of ocelli. Contrary to the views of Grenacher, Patten regards the ocelli of the larvæ of the water-beetles as practically closed vescicles, and composed primarily of three layers of cells, instead of open cups. In the posterior dorsal ocelli of the same beetle-larva Dr. Patten finds further a remarkable structure, in that on the dorsal side of these eyes exist two cell-layers, the outer of which seems to be continuous with the corneal hypodermis, while the other, the cells of which are elongate and rod-like, appears to be continuous with the retinal layer of the adjacent ocellus. These points, taken in connection with the facts that this extra-ocellar structure early becomes pigmented, and also receives a distinct nerve-supply, leads Dr. Patten to the view that this is but a dorsal extension of the true ocellus, and as pointing the way to the mode of division of the simple into the compound eye. The paper closes with some observations on the eyes of Phalangium.

Mr. F. E. Beddard, in the *Annals and Magazine of Natural History* for September, 1887, has a "Note on a New Type of Compound Eye," which he finds in Serolis and several species of Cymothoidæ, and which he regards as supporting Grenacher's rather than Patten's interpretations of some of the structures of the arthropod visual organs. The crystalline cone is secreted by two vitrella cells, and these have nothing to do with the secretion of the rhabdom of Grenacher (the pedicel of Patten). Below these vitrella cells come four elongate retinula cells, and between these are two large spherical transparent cells, and these six alone are concerned in the formation of the rhabdom, the outer four embracing it only at their outer extremities. This specialization of the retinula cells is regarded as a new feature, and one which recalls Patten's molluscan eyes, and especially his interpretation of Carriere's eye of Nereis. The author incidentally makes some corrections of his former account of the eye of Serolis, in the Report of the "Challenger" Expedition.

It may be stated, in conclusion, that American students promise to increase the literature of the arthropod eye to a considerable extent, as work is now being conducted upon the eyes of Limulus, Scorpions, Alpheus, Gammarus, and Trilobites, and possibly other forms.

Argiope riparia *var.* **multiconcha.**—For the past two years I have been studying an *Argiope*, which has sufficiently marked characteristics to entitle it to the rank of a variety of *A. riparia*, if not to a distinct species. The female is larger than any specimen I have seen of *A. riparia*, and she makes a group of cocoons, usually four, sometimes five, which she hangs in a cluster by the side of her snare, in the midst of an abundance of bright yellow, flossy silk. The cocoons are fashioned like those of *A. riparia*, and are about the same size. In honor of these multiple cocoons I call the spider *Argiope riparia* var. *multiconcha*.

Female 23 mm. long, first legs 33 mm. in length. The cephalothorax is about 9 mm. long, and nearly as wide as it is long, and covered with white hairs close up to the eyes. The two first legs are black, and the rest have the femora a deep orange-color. The abdomen is oval, and on the front is a sharp-pointed hump at each corner. The back of the abdomen is black interspersed with deep orange, darker than that of *A. riparia*, and the color is more irregular in outline than in riparia.

The under side of the body is colored and marked like *A. riparia*, and the epigynum is covered in the same way by a long black process.

The young look very different from the adult spider. Before the last moult there are five transverse bands of white and brown on the back of the abdomen. All of the legs are annulated with white and gray.

This spider lives in Guthrie, Missouri, and probably in other places. It frequents more sheltered places than our *A. riparia*. It likes to make its home under the roof of a piazza, and sometimes gets into houses, where, if undisturbed, it will hang its cocoons. I have a set of four cocoons that were made in a kitchen where a great cooking-stove was in almost constant use to supply the demands of a large family.—*Mary Treat.*

The Migration of the American Magpie to Eastern Nebraska, Twenty-five Years ago.—In Goss's "Birds of Kansas," 1886, p. 35, the magpie (*P. hudsonica*) is mentioned as "an occasional fall and winter visitant in Western Kansas," no mention being made of the magpie in Eastern Kansas. Dr. Aughey, in his list of "Birds of Nebraska," 1880, says "the magpie exists in Western and Northern Nebraska." Dr. L. E. Hicks, State University, in a private letter, dated November 4, 1887, says, "I have not seen the magpie in Eastern Nebraska, and only one in the western part: in Dawes County, last month. I have reliable information of a pair nesting near Grand Island. They undoubtedly breed in Nebraska."

Hence it is safe to conclude that the magpie (1887) is rather a rare bird in Eastern Nebraska, and most especially in the southeastern portion of the State. Such was not the case twenty or

thirty years ago. In questioning the early settlers about the birds of Southeastern Nebraska, between 1850–65, the magpie is usually the first bird mentioned. I am told by a dozen or more reliable persons that it was a greater pest than the common crow: pecking holes in the backs of fat hogs, eating off the tips of their ears, etc. They were very numerous in the fall and winter; one reliable witness stating that, about twenty years ago, he put out poison for the wolves, and on going to the spot the next morning found no less than forty dead magpies. The "Birds of North America in Smithsonian Institution," published in 1860, gives descriptions of twenty magpies killed in 1856, at various points on the Missouri from central Eastern Nebraska to the Black Hills.

I am fully satisfied that twenty or thirty years ago the magpie (*P. hudsonica*) made its annual fall and winter visit to the Missouri River bottoms, extending from Southeast Dakota to the Kansas State line, some few breeding in this section.—*W. Edgar Taylor, State Normal, Peru, Neb.*

Missouri River Crow-Roosts.—In vol. xx. p. 780, AMERICAN NATURALIST, it is stated that "the number of crows in the Western States, comparatively speaking, are so insignificant that their roosting-places have not been noticed by the ordinary observer." Probably the writer did not aim to include the Missouri Valley, yet such a conclusion seems to be general, but, undoubtedly, is incorrect.

A large roost of *C. americanus*, covering perhaps four or five acres, exists on Hogthief Island, in the Missouri River, about six miles above Peru, Neb., and fifteen miles below Nebraska City. Two other good-sized roosts are known, one ten miles north, and the other on an island eight miles south of Hogthief Island. Mr. N. S. Goss, author of "Kansas Birds," in a letter written October 29, 1887, says, "The crows had, several years ago, quite a large roost in a heavily-timbered bend on the Neosho River, in Allen County (Kansas), and I am informed that there is a roost on the Wakarusa River, in Douglas County, and without doubt there are several others in the State."

I am informed of several smaller roosts in Eastern Kansas and Southeastern Nebraska, but perhaps the greater number roost on Hogthief Island and contiguous territory. All the principal roosts, numbering, perhaps, not less than one hundred thousand crows, are in an almost direct north and south line not over one hundred and fifty miles in length. I am of the opinion that more than half of the above number roost on Hogthief Island and adjacent territory. The crows have been roosting on and near this island for at least twenty-five years, beyond which time, owing to the new settlement of the country, I have not, so far, been able to trace their history. Probably, at some time previous

to the settlement of the country, the crows at these various roosting-places in Eastern Kansas and Southeastern Nebraska had one roost,—different roosts being formed by the change of food-supply occasioned by the settlement of the country.

The crows assemble on the island named about the first of October and disperse about the first of May. About daybreak on a fine morning, when setting out for the day's journey, their chatter and noise, made in taking flight, may be distinctly heard in Peru, six miles away. A reliable witness, who has lived in the country for some ten or fifteen years, states that he has often "observed, flying in one direction, flocks of crows six miles long and one-half mile wide." In the winter the crows are so very plentiful in the surrounding country, including a radius of from twenty to forty miles, as to attract the attention of the most careless observer. Farmers have very often been compelled to guard their feed-pens. I have frequently been told by reliable persons that the crows in severe winters peck holes in the backs of hogs, in some cases eating off the ears.

Sometimes these crows roost in small bushes and large weeds, but generally in trees, often the willow or cotton-wood.

I am aware that many of these crows breed in this territory; this fact having been proven by Messrs. C. J. Pierson and J. M. Root, of the Normal Science Society, and by Mr. Goss and Professor Cragin, of Kansas. But it seems probable that some, at least, go to other territories for breeding; as several students living in Furnas, Hall, and other counties in Central Nebraska have noticed that in the summer and winter crows are very seldom seen, while large flying flocks are commonly observed in the spring and fall. However, we hope to investigate this point further, as well as determine something more definite as to numbers, former roosts, and mode of life.

The roost on the island may be plainly seen from the tower on the Normal School building.—*W. Edgar Taylor, State Normal, Peru, Neb.*

A Mink gnaws Iron Wire.—We have been troubled by minks in the trout-ponds and among the wild fowl in the water set apart for them. Six steel traps yielded four minks in three nights; two of these were caught by the fore leg and uninjured. A box was fitted with a partition, and the top of it covered with galvanized iron netting, one-inch mesh, such as is sold for poultry-yards. The first night they kept quiet, but the following one the large male gnawed a hole in the wire big enough to get his head through, and the wires cut his throat, so that he was dead in the morning. The female cut the wire sufficiently to get through, and was found loose in the room next morning. At present writing she is alive in the National Museum, where she was sent at the request of Prof. G. Brown Goode. I have kept

live minks with heavier wire-cloth, of smaller mesh, but never imagined that they could cut poultry netting.—*Fred. Mather, Cold Spring Harbor, N. Y.*

Fauna of Beaufort, N. C.—Beaufort has long been a favorite locality for zoological collectors, and the recent establishment there of the marine laboratory of the Johns Hopkins University has brought it into greater prominence. A recent number of the *Studies* of the university contains four papers on the fauna of the locality. Dr. McMurrich catalogues nine species of sea-anemones, *Sagartia pustulata* and *S. gracillima* being new. The molluscs of the region are enumerated by Dr. H. L. Osborn. His list is confessedly incomplete, but sixty-one species being enumerated outside of the group of Opisthobranchs, where the forms were not identified. Professor Nachtrieb, in his account of the ten species of echinoderms, gives considerable information of value, in that he mentions the probable or ascertained times of spawning of each species. Prof. O. P. Jenkins enumerates one hundred and thirty-four species in his list of fishes, of which twenty-three are not included in any previous catalogue of the fish-fauna of the locality.

The Pug-Dog and the Chihuahua Dog.—Two crania of pug-dogs which I have recently examined display identical dental characters, and show that the species cannot be referred to the genus Canis, but to the nearly allied form Synagodus Cope.[1] This genus differs from Canis in the presence of but two inferior true molars (one sectorial and one tubercular), and in the absence of the internal cusp from the inferior sectorial. The species may be called *Synagodus retusus*. It differs from *S. mansuetus* Cope, the type of the genus, in its excessively abbreviated muzzle and in the possession of two roots to the inferior tubercular tooth instead of one.

The Chihuahua, or naked Mexican dog, is the *Canis gibbus* of Hernandez,[2] and Pellone of the Mexicans. I have examined the dentitions of three specimens of this dog, and Professor Dugés has described and figured that of a fourth. In none of them is the second inferior molar present, and the internal cusp of the inferior sectorial is wanting in all. In other points the dentition is somewhat variable. The premolars are $\frac{2}{3}$ or $\frac{3}{3}$, and the true molars $\frac{0}{2}$, $\frac{1}{2}$, and $\frac{2}{2}$. In the specimen with three superior premolars the first two are rudimental. As the premolars are $\frac{4}{4}$ in Synagodus, the characters of the *C. gibbus* place it in the genus Dysodus Cope, where the premolars vary from $\frac{3}{3}$ to

[1] Proceedings Academy, Philadelphia, 1879, p. 186.

[2] See Dr. A. Dugés, Naturaleza, Mexico, 1880 (1882), p. 14, for an article on this dog.

$\frac{2}{2}$,[1] and where the second superior true molar is wanting. But one specimen of the *C. gibbus* possessed the second superior true molar. The species may be called *Dysodus gibbus*. It differs from the Japanese spaniel (*D. pravus* Cope) in its elongate muzzle, and in the great sparseness or absence of hair, in its erect ears, and in various other respects.

The characters of these genera are as well marked as those of non-domesticated forms of Canidæ. The deficiencies of dentition, although concomitants of reduced size, are not caused by it, since a majority of the extinct Canidæ, which preserve with great constancy the characters wanting in Synagodus and Dysodus, are of equal and smaller size.

I have had a female Japanese spaniel in my possession for eight years, and she has had pups several times. With one exception they never lived to be more than a few months old, and were of very erratic mental constitution. They displayed a great deal of ferocity in their family relations, nearly killing each other on several occasions. They nearly all died of convulsions.—*E. D. Cope.*

EMBRYOLOGY.[2]

The Rudimentary Pineal Eye of Chelonians.—In the *Quar. Jour. of Micr. Sci.* for October, 1886, W. Baldwin Spencer describes very fully the presence and structure of the pineal eye in Lacertilia, but makes no mention of its occurrence in any of the Chelonia. The other day, while looking over some sections prepared by the writer from an embryo of *Chrysemys picta*, presented by Dr. C. S. Dolley, Prof. J. A. Ryder called my attention to an organ which he took to be the pineal eye. Subsequent investigation showed this to be the case.

The embryo first cut was one measuring three-quarters of an inch from the tip of its nose to the end of the tail. The sections were made in a vertical longitudinal direction, and in the median line the structure referred to was found. The pineal outgrowth lies just behind the fore-brain; the proximal part of its stalk is tubular, while the distal end is flattened from above. It curves towards the tip of the snout, and its lower surface faces the inner margins of the cerebral hemispheres.

The eye occurs as a hollow vertical evagination from the upper surface of the pineal outgrowth, and leaves the stalk of the latter at the beginning of its distal fourth, measuring from its rear end. The two together, the eye and the pineal body, resemble very much in longisection the outline, as seen from the side, of the hammer of a gun.

[1] Naturalist, 1881, p. 233, where the dental characters of eight specimens are described.

[2] Edited by JOHN A. RYDER, Ph.D., Biological Department, University of Pennsylvania, Philadelphia.

Approaching the eye from without inward, one finds first the epidermis of the skin, then the corium, then a few irregularly-branched connective-tissue cells, the pia, and, finally, the outer surface of the eye. Surrounding it like a collar is a blood-sinus, which even after two or three years' preservation in alcohol was still filled with corpuscles, whose nuclei came out very sharply on staining in borax carmine.

The cells composing the eye are distinctly columnar throughout, with well-marked nuclei. The eye is balloon-shaped, or pyriform, and the cells on the upper half point towards the centre, while the remainder point towards the long axis of its short stalk. There is some fine thread-like or stringy material in the cavity of the eye which does not take the stain, and which is probably the coagulated remains of some serum or plasma which filled the cavity.

On looking at the upper surface of the head in other unstained, alcoholic, specimens of *Chrysemys picta*, there is no external evidence of the presence of this unpaired organ. In fact, the pineal eye in this type is evidently in a rudimentary condition; possibly in process of degeneration. No part of the outer wall of the optic vesicle of the pineal eye shows evidence of thickening into a lens, such as is found in that situation in many Lacertilia. It approximates, with its hollow stalk, somewhat towards the condition of *Cyclodus*, as described by Spencer, but there is no pigment developed anywhere in the pineal eye of *Chrysemys*.

However, in one specimen of unhatched *Cinosternum pennsylvanicum*, which, through Professor Ryder's kindness, I have had the privilege of examining, there is seen in the median line, half-way between the snout and the front end of the carapax, a clearly defined brownish pigment-spot. Judging from analogy and comparing my results with those of Mr. Spencer, we may expect to find the eye in this species much more highly developed than is the case in *Chrysemys* described above.

These observations are also of greater interest because of the fact that none of the Chelonians, in the adult condition, as far as I am aware, have a parietal foramen developed, such as is found in many Lacertilians. It is therefore clear that the pineal eye in Chelonians cannot at any time during life attain to even the functional importance of that organ in any of the Lizards in which it has hitherto been observed.—*George Fetterolf, Biological Laboratory, University of Pennsylvania*, November 9, 1887.

PSYCHOLOGY.

The Theology of Evolution.[1]—In the pamphlet bearing the above title is contained a statement of the evidence in favor of primitive and creative mind in nature, brought to light by the

[1] The Theology of Evolution, a lecture, by E. D. Cope; A Review of the Theology of Evolution, a reply to Dr. Montgomery, by E. D. Cope; The Relation of Mind to Matter, by E. D. Cope; all, 1887, Philadelphia, Arnold and Company.

doctrine of evolution. Its theses may be stated as follows: *First.* The mind of animals and men exercises a directive, though not a creative, power over their movements. This directive power is an evident direction of the course of energy by consciousness, and is, as such, a direct interference with mechanical process. *Second.* Since the evolution of animal types is due to their movements within their environment, and the movements have been inaugurated in conscious states by the directive power of will (*not* free will), the evolution of organic types is due to mind. *Third.* Since protoplasm is sustained as a chemical body against the ordinary chemical forces by the presence of vitality or some of its class of energies, the origin of protoplasm cannot be due to chemical energy, but to some energy of the vital type. This third thesis should be modified so as to read: Since protoplasm is decomposed as a chemical body by the attacks of living micro-organisms only, at ordinary temperatures, it is evident that vital energy possesses a direct control over the chemical energy. And vital energies are believed to possess no peculiarity by which they may be distinguished from the non-vital, excepting the stamp of a pre-existent or present consciousness.

From these premises it is inferred that there is and has been a primitive mind as an attribute or property of primitive matter. And this mind directs energy profitably to conscious beings and produces advantageous types of automatic energy by cryptopnoy. It thus acts as a building and creating agency, opposing the chemical and physical forces, whose outcome is destruction only, or the "dissipation of energy and the integration of matter."

In the second of the brochures referred to, the articles of the "Theology of Evolution" are stated as follows (p. 28):

"I. Nothing exists excepting tridimensional matter and its properties (or behavior).

"II. The properties of matter are energy (motion) and consciousness.

"III. Consciousness is not a property of universal matter, but is conditioned by the axiomatic qualities of matter, as extension and resistance.

"IV. The mode of motion (energy) of matter is, on the other hand, primitively conditioned by consciousness, but ceases to be so conditioned when it reaches a certain degree of automatism (to be better defined by future research).

"V. Consciousness ultimately disappears from matter and energy which have established automatic conditions; therefore the condition of the persistence of consciousness is the maintenan of will, the antagonist of mechanical automatism.

"VI. Every new process of conscious will creates new (? molecular) machinery in the conscious matter.

"VII. Hence physical and mental development depend on the will.

"VIII. The phylogeny of protoplasm requires a parent substance.

"IX. Since, then, the existence of primitive mind in a primitive physical basis is far more probable than the opposite view, the existence of a Supreme Being is exceedingly probable.

"X. Since will controls the movements and organization of matter, the persistence of human consciousness in other worlds than the earth is possible."

Dr. Edmund Montgomery combats these views in a series of nine articles, published in the *Open Court*, of Chicago, under the heads "Cope's Theology of Evolution" and "Are we the Products of Mind?" He asserts with regard to the theses of Cope's first pamphlet: *first*, that mind does not, because it cannot, control or direct the movements of matter; *second*, that consciousness is not the director of the evolution of living beings; *third*, that "primitive mind in primitive matter" would be of the lowest grade of mind from lack of organization, and could only represent a Deity inferior to man and many of the animals.

Dr. Montgomery also holds that mind is not a property of matter, and further takes the idealistic position in metaphysics that "matter is only a superfluous impediment easily argued away." But at the same time he holds the very distinct and apparently inconsistent opinion that mind can only exist in connection with highly organized protoplasm. His denial that mind can control matter is absolute, and he substitutes for this opinion a theory of "special hypermechanical energies" not yet formulated. The objections of Dr. Montgomery are replied to by Professor Cope in the second and third brochures referred to, and in a fourth in the *Open Court*, of Chicago, entitled "Idealism and Evolution."—*E. D. Cope.*

An Expression of Animal Sympathy.—While riding along a country road in the environs of Cincinnati, Ohio, about the 1st of last October, I noticed a remarkable and very amusing display of animal intelligence. In a field beneath some trees at the bottom of a very high hill stood facing each other a donkey and a young bull. The bull was standing very patiently, slightly nodding his head up and down, while the donkey, with a rather heavy stick about two feet long in his mouth, was scratching his companion's forehead. We stopped our horse and watched the operation for some time. Once the donkey dropped his instrument, but, without hesitation, lowered his head, picked up the club again with his teeth, and continued scratching very gravely, to the evident satisfaction of the bull. We often see two cows "rubbing horns," and whether this was a return for a similar favor from the bull or not, the donkey very clearly realized his poverty in the matter of horns, and happily supplied the deficiency.—*Charles L. Edwards.*

MICROSCOPY.[1]

Method of Photographing Serial Sections.—The development of microtomical technique has made it a comparatively easy matter to produce great numbers of fine sections in a very short time. As the sections with which an anatomist or an embryologist has to deal are generally too small for macroscopical examination, it is often difficult to obtain an outlook over the material accumulated. The microscopical examination of hundreds or thousands of serial sections, if only for the purpose of general orientation, is a slow and tedious work. One cannot carry the picture of the series along while examining the sections, one by one, with the microscope. This can only be accomplished indirectly, through representations enlarged just enough to make it easy to examine them macroscopically. To make outline sketches of the whole series, or at least of the more important portions of it, calls for an enormous sacrifice of time, together with a large amount of most fatiguing mechanical labor. Much more satisfactory results may be obtained by the aid of photography, and with relatively little expenditure of time and energy.

Professor His,[2] of Leipzig, to whom we are indebted for the "embryograph" and a method of "plastic reconstruction," previously described in this journal, employs the apparatus seen in the accompanying cut for photographing serial sections.

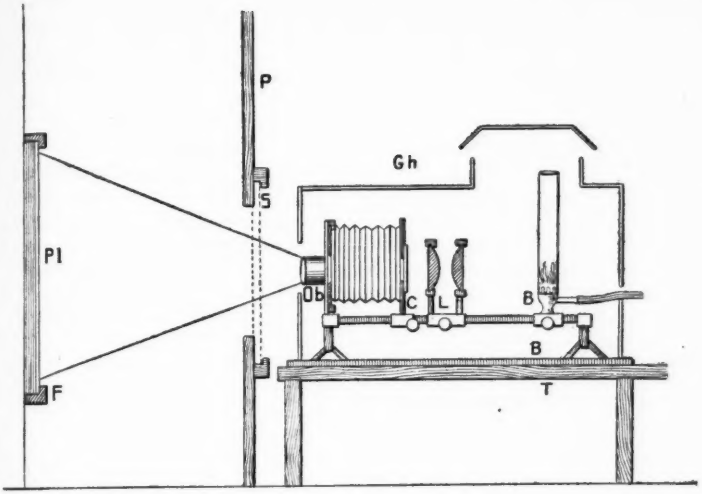
The objective (Ob) is a Steinheil *antiplanatic* of 12 cm. focal distance, or an *aplanatic* of the same factory of 14 cm. focal distance. The latter gives a little less light than the former, but possesses the advantage of an accurate and uniformly-sharp definition.

For embryos that are not exceptionally small, a magnification of ten to fifteen diameters generally suffices. With any magnification not exceeding twenty diameters all the sections mounted under a cover-glass 3 cm. square can be reproduced at the same time. Long series of sections can thus be photographed in a short time, and the material so obtained is invaluable, not only as a means of general orientation, but also as a reliable basis for "plastic reconstruction" of every kind.

The projection-apparatus consists of a horizontal rack carrying at the anterior end a plate with the photographic objective (Ob); behind this a second plate (C) (with a central perforation), connected with the first by a bellows, and serving as a carrier for the object-slide; then a double condenser (L) 11.5 cm. in diameter, with a focal distance of 8 cm.; and, behind all, an argand gas-burner (B).

[1] Edited by C. O. WHITMAN, Ph.D., Milwaukee, Wisconsin.

[2] W. His, "Ueber das Photographiren von Schnittreihen;" Arch. f. Anat. u. Phys., Anat. Abth., 1887, 2d and 3d Heft, p. 174.



The rack bearing all these parts has two feet resting on a base-board (B), which can slide forward or backward between guides on the table (T). The coarse adjustment is effected, first of all, through this sliding movement of the base, and then by a screw-movement of the object-carrier (C). The fine adjustment is made by turning the objective, which works in a fine screw. Extraneous light is excluded by inclosing the whole apparatus in a tin box (Gh) provided with a wide side-door.

The size and distance of the picture vary within relatively large dimensions, so that an ordinary photographic camera could not conveniently be employed. The arrangement is such that the picture is projected upon the wall of the dark-room, in front of the objective, instead of a ground-glass behind it, as in the ordinary camera.

The dark-room is divided by a partition (P), which is provided with a door and a sliding screen (S). On the wall opposite the screen is fixed a large frame (F), which carries a glass plate (Pl). The image is first brought to a focus on a sheet of white paper behind the glass plate; and then, after closing the screen, the white paper is replaced by the photographic paper.

The photographic paper, known as the "Eastman bromide-of-silver paper," is sensitive enough for use with lamp-light, and the manipulations are extremely simple.

The time of exposure varies according to the magnification and the diaphragm employed. With the Steinheil aplanatic and diaphragm (4) an amplification of ten diameters requires an ex-

posure of six to eight minutes. Very thin, transparent sections require less time than thick or deeply-stained ones.

The pictures are, of course, negative, but they are none the less valuable for the purposes before named. If positive pictures are desired these are easily obtained, as the photographic paper is sufficiently transparent to admit of copying. For this purpose lamp-light is better than sunlight, and an exposure of one-half to one minute is sufficient. Both the negative pictures and the positive copies admit of further finish with pencil or color.

Full details of manipulation are furnished with each package of the Eastman paper. The operations which follow exposure are (1) softening of the paper in water; (2) development of the picture by means of potassium oxalate and ferrous sulphate; (3) washing in acidified water; (4) fixation through hyposulphite of sodium; (5) washing and drying.

SCIENTIFIC NEWS.

—In the November number of the AMERICAN NATURALIST Mr. J. F. James kindly calls my attention and that of the general public to what seems to be a slight put upon his work. A word of explanation seems to be due both to Mr. James and myself. The object of the paper entitled "Origin of the Indiana Flora" was simply to apply well-known facts with regard to the North American flora to the specific case of Indiana. In order to do this it seemed necessary to give an introduction containing an explanation of the general problem for those for whom the writing was intended,—a thing that would not have been necessary for the scientific public. My former assistant, Mr. Thomson, was asked to look up the literature of the subject and prepare as compact a statement as possible of the known facts. I suppose that he found Mr. James's paper useful, as being the most concise compilation of facts so well known as to have become general property. That due credit was not given to Mr. James for this assistance was a great oversight, but that it could not have been intentional appears in the very extracts that Mr. James has culled out. He is there mentioned by his full name as an authority for some statement or other. I am blameworthy for not more closely inspecting this part of the work, but, as the chief trouble was failure to give full credit to Mr. James, it is hereby done, with an expression of regret that the omission was not seen in time to remedy it.—*John M. Coulter.*

—The Imperial University of Japan has recently established a marine biological station at Misaki, a day's journey from Tokio, an account of which has recently been published by Professor Milsukuri in vol. i. of the *Journal of the College of Science* of the

university. The building is of wood; the laboratory-room is forty-eight feet long by from twelve to eighteen in width, and affords space for about ten workers. Besides this there is a room for sorting specimens and another for library purposes, while the second story affords sleeping-rooms. Salt water runs to the tanks and aquaria in the laboratory. Misaki is favorably situated for biological investigation, and the catalogue of fauna outlined by Professor Mitsikuri is tantalizing. Foraminifera, Radiolaria, glass sponges (Hyalonema and Tetilla), corals, and Pennatulids, a Pentacrinus "two or three feet long," Chiton, Haliotis, Doliolum, pteropods and heteropods, Actinotrocha, Tornaria, Pilidium, etc., characterize the general facies of the locality when viewed from the zoological side.

—Dr. G. H. Sternberg, U. S. A., has just returned from Havana. He was sent by the U. S. Health Commission to examine the claims of the various methods reported by physicians in Rio Janeiro, Vera Cruz, and Havana for combating yellow fever by inoculation. The discovery of the supposed yellow-fever bacilli has been followed by attenuation cultures, after the method of Pasteur. Dr. Sternberg has brought with him culture series of these bacilli from all these localities, and will proceed to develop them and test their merits as preventives of this dread scourge of the tropics.

—Prof. Alfred Giard, of Lille, has been called to Paris as "maître de conférences à l'Ecole normale supérieure."

—Dr. O. S. Jensen, who had just published a valuable paper on "Spermagenesis in Mammals, Birds, and Batrachia," died in Christiania, September 14, 1887, aged forty years. He was a skilful anatomist.

—Professor Hugo Lojka, of Buda-Pest, a student of lichens, died September 7.

—In the death of Mr. Oscar Harger, which occurred at New Haven, November 6, of cerebral hemorrhage, science has lost an able and conscientious worker, whose labors are none the less important because they are not widely known. Born at Oxford, Conn., in 1843, his early years were spent upon a farm, where, while his educational facilities were very limited, he became imbued with that love of natural history to the study of which his life has been devoted. His attention was early directed to botany, a subject which he pursued with unabated zeal throughout life, and it was the success that attended his early efforts in this study that induced him, as he has told me, to prepare for college, which was accomplished largely without pecuniary aid. He graduated at Yale College in 1868 with high honors, the expenses of his course having been chiefly defrayed by his own exertions in

mathematical calculations for life-insurance companies and for Professor Newton. The two following years were spent in natural history studies in Sheffield Scientific School with Professor Verrill and his most intimate friend, Prof. S. I. Smith. In 1870 he was appointed assistant in palæontology to Professor Marsh, a position he uninterruptedly held to his death.

His life for twenty years has been wholly that of a student and investigator, but the published works by which he is known to the scientific world are not numerous or extended, though important. His chief work was a "Report on the Marine Isopoda of New England and Adjacent Waters," published in 1880, but he also published not a few other papers in the *American Journal of Science*, and elsewhere, on isopods, myriapods, and a fossil spider (Arthrolycosis) from the Coal-Measures. The real work of his life, however, will never be appreciated save by those who knew him well. A patient and accurate observer, possessed of truly remarkable logical powers, and a man of very extensive and most accurate knowledge, the results of his eighteen years' work in vertebrate palæontology have been of great value, notwithstanding the fact that none of them have been published by him. In eight years' daily intimate association with him in the Yale College Museum, I cannot recall an instance where his matured opinions and statements were assailable; errors he made, of course, but they were fewer than I have ever known in any other person. Unfortunately, his opinions, though never gainsaid, were not always followed. To my personal knowledge, nearly or quite all the descriptive portion of Professor Marsh's work on the Dinocerata was written by him, and was published without change, save verbal ones. The descriptive portion of the Odontornithes was likewise his work, but this I cannot say from personal knowledge.

Born with unsound physique, his life has been a constant struggle with difficulties that a man with a less indomitable will would have found unconquerable; that he has lived for the past eight years has been a surprise to his physicians and friends. He was firm and pronounced in his opinions, but withal of a very modest and retiring disposition. The few intimate friends that knew him cherished and respected him in a remarkable degree. He was married in 1875 to Miss Jessie Craig, of New Haven, who survives him without children.—*S. W. Williston.*

—Ferdinand V. Hayden, M.D., Ph.D., the well-known geologist, died December 22 at his residence in Philadelphia, after an illness which had confined him to his room for over a year and a half.

He was born in Westfield, Mass., September 7, 1829, and at an early age emigrated to Ohio, and was graduated from Oberlin College in 1850. He afterwards studied medicine at the Albany

Medical College, taking his degree in 1853. He did not practise medicine, but in the spring of the year of his graduation visited the "Bad Lands" of Dakota on White River in the interest of Prof. James Hall, explored one of the remarkable ancient deposits of extinct animals, and returned with a large and valuable collection of fossil vertebrates. He spent the three following years in exploring the Upper Missouri, and his large collection of fossils was partly given to the Academy of Sciences in St. Louis and a part to the Academy in Philadelphia. These collections attracted the attention of the officers of the Smithsonian Institution, and he was appointed, at the suggestion of General J. A. Logan, geologist on the staff of Lieutenant G. K. Warren, of the Topographical Engineers, who was then making reconnoissance of the Northwest, and continued on duty till 1861, when he entered the war as a surgeon of volunteers. He was brevetted lieutenant-colonel for meritorious services at its close.

In 1865 he was elected Professor of Geology and Mineralogy in the University of Pennsylvania, and held that post until 1872, when he resigned on account of the increased labor in managing the survey. In the summer of 1866 he made another expedition to the Upper Missouri.

The United States geological survey of the Territories, under charge of Professor Hayden, was commenced in the spring of 1867 and continued until 1879. Seven annual reports of the survey have been published in 8vo, and eight volumes of the quarto final report. Three volumes of the 4to series are not yet published.

His reports of the exploration of the famous Yellowstone region in 1870 and 1871 induced Congress to set apart by law as a national park three thousand five hundred and seventy-five square miles of the public domain, containing within its limits most of the geysers, hot springs, and other wonders of that region.

The United States owes to Dr. Hayden the establishment of its Geological Survey. Those acquainted with the history of this great work can testify to the energy and perseverance which he expended in accomplishing it, qualities which were in a high degree inherent in Dr. Hayden's character. Dr. Hayden's influence was only second to that of Baird in securing for science the aid and recognition which it has received from the government of the United States. And at the period of his greatest success Hayden was always the same unpretentious and enthusiastic seeker for knowledge. He was singularly free from sordid motives, and he left the service of the government a poor man. His retirement was caused by an intrigue discreditable to all who participated in it. His removal from the position which he had won through so many years of toil, was influential in bringing on the disease to which he succumbed.

Dr. Hayden left a widow but no children.

—By the death of Prof. William Stebbins Barnard, on the 13th of November, in his thirty-ninth year, American Science has lost a biological investigator and teacher of unusual ability, training, and originality.

Dr. Barnard was born at Canton, Ill., on the 28th of February, 1849. After a year at the University of Michigan, he entered Cornell University at its opening in 1868. While a student he paid special attention to Natural History, and was selected by the late Prof. Chas. Fred. Hartt to assist in his expedition to Brazil. In that country Dr. Barnard made important explorations and collections, and some of his specimens are in the museum of Cornell University. After graduating in 1871, he spent two years under the best teachers in Germany, and on taking the degree of Ph.D. at Jena, in 1873, received from Haeckel a personal certificate that in his studies he had "shown the highest degree of excellence." Returning to Cornell, he made many observations and drawings of the Protozoa, on which group he gave courses of lectures at the University, at the Anderson School on Penikese Island, in the summer of 1874, and at the summer schools in Normal and Peoria, Ill., in 1875. From 1876 to 1878 he was professor of natural science in the Oskaloosa (Iowa) Normal School, and then for two years gave at Cornell University the instruction in entomology and invertebrate zoology during the absence of Prof. J. H. Comstock as United States entomologist. Under Professor Comstock's successor he became an assistant in the entomological division of the Bureau of Agriculture, and during the following five years made valuable observations upon destructive insects, and devised several appliances for spraying insecticides upon the cotton-worm and other forms; his apparatus and experiments are described in the department reports and bulletins, and were highly commended by the chief of the division.

During the last two years he was professor of natural history in Drake University, Des Moines, Iowa, whose faculty and students at his death adopted resolutions expressing their affection, esteem, and sense of irreparable loss.

Besides his contributions to the U. S. Entomological Reports, Dr. Barnard's publications were as follows:

1. "Observations on the Membral Musculation of *Simia satyrus* (orang) and the Comparative Myology of Man and the Apes." *Amer. Asso. Proc.*, August, 1875, pp. 30, two plates.

2. "Observations on the Development of *Didelphys virginiana*" (the opossum). *Ibid.*, pp. 2, one plate.

3. "Catalogue of the Invertebrates" (excepting insects) in Ward's natural science establishment, octavo, pp. 96, eight plates. Rochester, 1876.

4. "New Rhizopods," pp. 3, one plate. *Amer. Quar. Microscopical Journal*, 1879.

5. "Zoological Education." Read before the University Convocation, July 13, 1879. Report of the Regents of the University of the State of New York, 1879, pp. 529–532.

6. "Protoplasmic Dynamics." AMER. NATURALIST, April, 1880, pp. 10, five figures. Hundreds of accurate and beautiful drawings and diagrams, with notes and manuscripts equivalent to several large volumes, bear witness to his scientific spirit and industry, and indicate what he might have put in shape for publication but for imperfect health and an almost too faithful devotion to his duties as a teacher.

In 1874, Dr. Barnard married Miss Mary Nichols, sister-in-law of Prof. B. G. Wilder. A son inherits much of his father's general ability, artistic talent, and fondness for natural history.—*B. G. W.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Natural Science Association of Staten Island.—October 8, 1887.—Dr. A. L. Carroll and Mr. Arthur Hollick exhibited specimens of the material from an artesian well at Bachmann's brewery, Clifton, in which the recent alleged discoveries of gold, copper, and rubies were reported. The specimens, said to have come from the lowest depth (about nine hundred feet), were typical New York Island rock, being a mica-schist containing garnets, which were probably mistaken for rubies. In this connection it is of interest to note that Dr. N. L. Britton predicted the finding of this rock below and to the eastward of our serpentine, in case a sufficient depth was reached. (*Annals of the N. Y. Acad. of Sciences*, vol. ii., Nos. 5 and 6, April 4, 1881.) The greatest interest was, however, centred in a specimen of conglomerate, consisting of pieces of wood, mortar, and scraps of iron and brass cemented together with sesquioxide of iron. It was not stated whether specimens of this material were the ones analyzed, but if they were it would not be difficult to account for the finding of copper, iron, and perhaps other metals, as it is evidently the refuse of some metal-working establishment, and is of recent formation.

Mr. Hollick exhibited drawings of lemon-pits, which had germinated while inside the lemon. One had developed two imperfect *green* cotyledons, and had pushed its way for about three-quarters of an inch through the pulp of the fruit.

A skin-scraper and several arrow-heads, from Old Place, presented by Mr. L. W. Freeman, were shown. Also a skin of the spotted warbler (*Dendræca maculosa*), obtained by Mr. R. H. Britton, at New Dorp, on May 7. The same species had been noted on May 15 in the neighborhood of Eltingville by Messrs. Wm. T. Davis and Arthur Hollick.

Mr. Jas. Raymond stated that while sailing in a cat-boat, near the Long Island shore, a fish-hawk lit on the mast-head, where it remained some time, but finally flew to the mast of a schooner lying near by. These birds visit Staten Island in early spring, but are particularly numerous in late summer and autumn. They frequent the sea-shore and ponds, and many are shot while perching on certain favorite dead trees, eating their prey. So far as known only one pair of these birds has attempted to nest on the island. The nest was in process of construction on June 14, 1874, in a partly dead chestnut-tree on the meadows near Garretson's, but the birds were frightened away before completing it. If protected from persecution there is apparently no reason why they should not nest here as freely as they do along the coast of New Jersey.

Mr. E. M. Eadie reported the capture of a walking-stick insect (*Diapheromera femorata*) at Old Place. It is of quite rare occurrence, only three other specimens having been collected by members of the Association on Staten Island within the past six years.

Boston Society of Natural History.—The first general meeting for the season was held on Wednesday evening, November 2, 1887. Prof. William M. Davis spoke of the "Physical History of the Somerville (Mass.) Slates;" Dr. W. G. Farlow discussed the "Conception of Species in Cryptogamic Botany;" and Dr. J. Walter Fewkes described a "New Mode of Life among Medusæ."

November 16.—The question of holding the general meetings once or twice a month was decided in favor of twice a month. Prof. A. Hyatt spoke of the values in classification of the stages of growth and decline, and propositions for a new nomenclature. Mr. S. H. Scudder described the means employed by the butterflies of the genus Basilarchia for the perpetuation of the species. Prof. Wm. T. Sedgwick spoke of the new American *Journal of Morphology* and the "Lake Laboratory of Biology at Milwaukee."

Biological Society of Washington.—The one hundred and sixteenth regular meeting was held on Saturday evening, December 3, 1887, in the Assembly Hall of the Cosmos Club. The following communications were read: Mr. Charles Hallock, "The Great Roseau Swamp;" Dr. C. A. White, "On the Rapid Disappearance of the Cast Antlers of the Cervidæ;" Dr. Theobald Smith, "Peptonizing Ferments among Bacteria;" Mr. C. D. Walcott, "A Fossil Lingula preserving the Cast of the Peduncle;" Dr. Theo. Gill, "The Phylogeny of the Cetacea."

INDEX TO VOL. XXI.